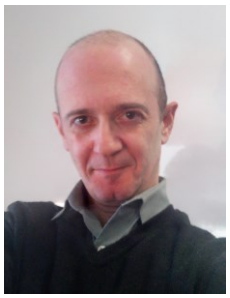
Alessandro Fraleoni Morgera

Curriculum Vitae



Nome e cognome**: Alessandro Fraleoni Morgera**
Luogo e data di nascita**: Roma, 23/02/1970**
Stato civile**: coniugato**
Nazionalità**: Italiana**

Profilo Generale

- Laurea in Chimica Industriale, Dottorato di Ricerca in Chimica Industriale (Scienza dei polimeri), Master in Direzione Aziendale.
- Esperienza di lavoro sia in ambito privato (responsabile organizzazione della produzione in azienda di estrusione materie plastiche) che accademico (Professore Associato in Scienza e tecnologia dei materiali presso il Dipartimento di Ingegneria e Geologia dell'Università di Chieti-Pescara).
- Esperienza di rapporti istituzionali tra enti pubblici ed enti di ricerca.
- Esperienza di trasferimento tecnologico efficace.
- Buone capacità di relazione ed organizzative, marcata propensione a costruire reti di collaborazione e a massimizzare il risultato del lavoro di ogni componente del network, forte attitudine al problem solving e al lavoro progettuale, con orientamento a soluzioni e progetti a medio-lungo termine e allo sviluppo sostenibile delle attività.

Expertise manageriale

- *Coordinamento di unità locali di ricerca* (1-5 persone) in progetti regionali ed europei ed in attività di ricerca indipendente;
- *gestione di attività di ricerca in coordinamento con altri gruppi di ricerca*, sia nazionali che internazionali;
- *gestione di progetti complessi*, con:
    - pianificazione e gestione del reperimento di finanziamenti;
    - stesura di budget preventivi;
    - contabilità progettuale e basata su centri di costo;
    - organizzazione di gruppi di lavoro e gestione risorse umane;
    - organizzazione e tenuta riunioni;
    - monitoraggio stati di avanzamento dei lavori programmati (Gantt, PERT);
    - stesura di reports di progetto e preparazione deliverables;
    - comunicazione di risultati progettuali ai partners, alla comunità scientifica, ai finanziatori e al pubblico indistinto.
- *capacità di interazione fruttuosa tra enti di ricerca e aziende private*, con visione completa dei processi di innovazione scientifica e trasferimento tecnologico (incluse le problematiche più comuni, come gestione di brevetti, ricerca finanziamenti, creazione di opportunità di accesso al mercato, e i relativi metodi di risoluzione);
- *capacità di ideazione e gestione di progetti didattici articolati di livello universitario* (pianificazione dei contenuti e della comunicazione, interazione con soggetti accademici e con aziende, preparazione corsi, reperimento risorse ed espletamento di pratiche per borse di studio, ecc, con particolare riferimento a Master universitari di secondo livello - masterinrobotics.units.it);
- *capacità di interfacciarsi con associazioni di categoria e organizzazioni sindacali* per la risoluzione di problematiche lavorative;
- *capacità di comunicazione dei risultati di una struttura/gruppo all'esterno* attraverso media tradizionali (giornali, televisioni, radio) e moderni (web, email, social).

Expertise tecnico-scientifica

- Scienza e tecnologia dei materiali: tecniche e tecnologie pratiche di manipolazione e analisi di materiali avanzati, inclusi nanocompositi per applicazioni navali, polimeri, materiali organici, con focus sulle nanotecnologie (deposizione e caratterizzazione di films sottili/ultrasottili/monomolecolari, processing di materiali plastici per estrusione, fabbricazione di nanostrutture per autoassemblaggio e/o crescita chimica, sintesi di polimeri, realizzazione di nanocompositi, spettrofotometria UV-Vis, infrarosso, calorimetria, cromatografia, microscopia ottica ed elettronica, microscopia a scansione);

- fabbricazione e caratterizzazione di dispositivi elettronici/optoelettronici basati su materiali organici (sensori di gas, celle fotovoltaiche, fotodiodi, OLEDs), con esperienza nella caratterizzazione di base della risposta elettrica dei semiconduttori organici;
- Uso di PC/Windows e Macintosh, incluse applicazioni varie (Word, Excel, Power Point, software per elaborazione formule chimiche, email managers, WWW Browsers e motori di ricerca, inclusi quelli scientifici - Scopus, Google Scholar, graphical processing, data processing;

Profilo professionale

Marzo 2020 - Oggi - *Dip.to di Ingegneria e Geologia, Univ. di Chieti-Pescara, Italia*

- ***Professore Associato.***
  - *Responsabilità di insegnamento*: Corso di Materiali e biomateriali per applicazioni odontoiatriche (4 CFU) per la Laurea Magistrale in Ingegneria Biomedica; Corso di Scienza dei Biomateriali (6 CFU) per la Laurea Triennale di Ingegneria Biomedica; Corso di Scienza e Tecnologia dei Materiali per il Master in Tecniche di fisiopatologia cardiocircolatoria e perfusione cardiovascolare attività seminariale (2 CFU); Corso di Materiali da costruzione per la Laurea Magistrale di Ingegneria delle Costruzioni (6 CFU); Corso di Materiali e Tecnologie di produzione per la Laurea triennale in Design (6 CFU)
  - *Responsabilità accademiche*: Presidente del Corso di Laurea Magistrale in Ingegneria Biomedica; membro del Comitato di Indirizzo (rapporti con le Imprese ed il Territorio) del Dipartimento di Ingegneria e Geologia.
  - *Responsabilità di ricerca*: responsabile di unità per progetti di ricerca nazionali (attualmente un PRIN 2022).
  - Professore Affiliato presso l'Istituto di Biorobotica della Scuola SUperiore di Studi Avanzati Sant'Anna (Pontedera - Pisa) tra il 2021 ed il 2023; affiliazione in corso di rinnovo

Giugno 2019 - Ottobre 2019 - *Dip.to di Ingegneria e Architettura, Univ. di Trieste, Italia*

- Contratto di collaborazione con il Dip.to di Ingegneria e Architettura dell'Univ. di Trieste per l'analisi del processo di impregnazione con resina isolante di avvolgimenti elettrici per utilizzo industriale nell'ambito di una collaborazione con un'azienda del settore.
- Nell'ambito di una collaborazione in essere con Plaxtech srl (azienda che ha sviluppato un innovativo processo di estrusione di materie plastiche eterogenee da riciclo), co-vincitore di un progetto proposto da Electrolux SpA per il riuso di scarti industriali a scopo di produzione di manufatti plastici in regime di economia circolare (12 mesi di collaborazione attiva tra Plaxtech ed Electrolux al co-sviluppo della tecnologia. Progetto iniziato a Ottobre 2019; ruolo nel progetto: advisor Plaxtech per R&D).

Sett. 2017 - Maggio 2019 - *Dip.to di Ingegneria e Architettura, Univ. di Trieste, Italia*

- ***Ricercatore a Tempo Determinato***, ex art. 24, comma 3, lett. a) della Legge 240/2010.
  - *Responsabilità di insegnamento*: 3 CFU in Scienza, Chimica e Tecnologia dei Materiali (materie trattate: tecnologie di processo di films sottili di ossidi trasparenti conduttivi, plastiche conduttive, nanotubi, grafeni e nanofili metallici; materiali termoisolanti per l'edilizia; metodi di impermeabilizzazione di cementi; finestre intelligenti) e attività seminariale (12 ore erogate nel Master in Robotica, su sensori utilizzabili in Robotica per applicazioni attiche).
  - *Responsabilità di ricerca*: responsabile di unità/workpackage per progetti regionali.
  - *Responsabilità istituzionali*: Co-organizzatore del Master in Robotics 2018-19 dell'Università di Trieste. Coordinatore Scientifico di detto Master.
  - *Responsabilità progettuali*:
    - **2018**: Responsabile dell'Unità di Ricerca dell'Università di Trieste del progetto regionale FVG "ISOLCOL", sotto il programma POR-FESR; chiusura del progetto con successo a Giugno 2018.
  - *Altre attività istituzionali*: partecipazione a commissioni di laurea, sorveglianza ad esami di accertamento capacità di base per ammissione a corso di Ingegneria (TOLC), partecipazione a commissioni del Rapporto del Riesame e al Gruppo Assicurazione Qualità di Dipartimento.
  - *Supervisione* di tesi di laurea, sia triennali che magistrali, e di Dottorati di Ricerca.
  - *Temi di ricerca seguiti*: crescita per via chimica di ZnO nanopillars (ricerca indipendente), crescita e caratterizzazione di OSSCs per applicazioni elettroniche/optoelettroniche e per ricerca di base (sia

basata su progetti che indipendente), fabbricazione per auto-organizzazione di nanostrutture basate su materiali organici e inorganici (inclusi polimeri, molecole, nanotubi di carbonio, nanoparticelle inorganiche) (ricerca indipendente), inkjet printing e patterning di semiconduttori organici e nanoparticelle metalliche (sia basata su progetti che indipendente), nanocompositi per isolamento termico in applicazioni navali (ricerca basata su progetti).

- **Ott. 2013 - Sett. 2017** - *Dip.to di Ingegneria e Architettura, Univ. di Trieste, Italia, e Sincrotrone Trieste SCpA, Basovizza (TS), Italia*

  - **Ricercatore a Tempo Determinato** (ex art. 24, comma 3, lett. a) della Legge 240/2010), e **Associato di Ricerca alla Sincrotrone Trieste**.

    Per l'Università di Trieste:
    - *Responsabilità di insegnamento*: 3 CFU in Scienza, Chimica e Tecnologia dei Materiali (materie trattate: tecnologie di processo di films sottili di ossidi trasparenti conduttivi, plastiche conduttive, nanotubi, grafeni e nanofili metallici; materiali termoisolanti per l'edilizia; metodi di impermeabilizzazione di cementi; finestre intelligenti);
    - *Responsabilità di ricerca*: responsabile di unità/workpackage per progetti europei e regionali. Supervisione di tesi di laurea, sia triennali che magistrali, e di dottorati di ricerca.
    - *Responsabilità progettuali:*
      - **2017**: Responsabile dell'Unità di Ricerca dell'Università di Trieste del progetto regionale FVG "ISOLCOL", sotto il programma POR-FESR (grant per l' Univ. di Trieste di ca. 140.000 €, vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli), progetto partito a Marzo 2017.
      - **2015**: Responsabile per grant di 5.000 € per un piccolo progetto in collaborazione con Azienda italiana del settore navale, su nuovi materiali per l'isolamento termico.
      - **2013**: Responsabile del WorkPackage 2 e dell'Unità di Ricerca dell'Università di Trieste per il progetto Europeo “iFLEXIS”, sotto il programma FP7-ICT (grant per l'Univ. di Trieste: ca. 440.000, vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli), progetto iniziato a Ott. 2013 e chiuso nel 2016 con successo.
    - *Altre attività istituzionali*: partecipazione a commissioni di laurea, sorveglianza ad esami di accertamento capacità di base per ammissione a corso di Ingegneria (TOLC), partecipazione a commissioni del rapporto del riesame e al Gruppo Assicurazione Qualità di Dipartimento.
    - *Supervisione* di tesi di laurea, sia triennali che magistrali, e di Dottorati di Ricerca.
    - *Temi di ricerca seguiti*: perovskite-based solar cells (ricerca indipendente), crescita e caratterizzazione di OSSC per applicazioni elettroniche/optoelettroniche e per ricerca di base (sia basata su progetti che indipendente), fabbricazione di nanostrutture basate su materiali organici e inorganici (inclusi polimeri, molecole, nanotubi di carbonio, nanoparticelle inorganiche) per auto-organizzazione (ricerca indipendente), inkjet printing e patterning di semiconduttori organici e nanoparticelle metalliche (ricerca sia basata su progetti che indipendente).

    Per la Sincrotrone Trieste:
    - **2012-2013:** Responsabile dell'Unità di Ricerca della Sincrotrone Trieste per lo sviluppo e la realizzazione di compositi polimero/nanoparticelle/nanotubi per applicazioni in prostetica (progetto nazionale “Procerpol”: grant per la Sincrotrone Trieste: 222.000 €, vedere la sezione "Raccolta Fondi e Finanziamenti " per i dettagli). Progetto uficialmente iniziato il 1° Ott. 2012, ma poi abortito per abbandono da parte dell'Azienda capofila del progetto.
      Dal 2014 al 2017 nessun task attivo, eccetto beamtimes svolti presso la Sincrotrone e chiusura di attività ancora aperte (rendicontazioni progetti, passaggi di consegne).

Sett. 2008 - Sett. 2013 – *Sincrotrone Trieste SCpA, Trieste, Italia*

- **Ricercatore a tempo determinato** (contratto settore metalmeccanico).
  - *Principali linee di ricerca*: OLEDs polimerici (ricerca basata su progetti), celle fotovoltaiche e fotodiodi polimerici (ricerca basata su progetti), dye-sensitized solar cells (ricerca basata su progetti), organic semiconducting single crystals (OSSCs) per applicazioni elettroniche/optoelettroniche e per ricerca di base (ricerca indipendente), fabbricazione di nanostrutture basate su materiali organici e inorganici (inclusi polimeri, molecole, nanotubi di carbonio, nanoparticelle inorganiche) per auto-organizzazione (ricerca indipendente).

- *Responsabilità istituzionali*: rappresentante di Sincrotrone Trieste per la piattaforma tecnologica europea (ETP) Sustainable Chemistry (SusChem) e Membro del Core Group Materials della piattaforma tecnologica europea SusChem.
- *Altre attività istituzionali*: Collaboratore dell'Ufficio Progetti di Sincrotrone per le proposte EU FP7 e dell'Industrial Liason Office Sincrotrone per le problematiche e le policies collegate alla proprietà intellettuale. Advisor per Sincrotrone della risistemazione di un laboratorio chimico per ricercatori interni, per esperimenti legati ai beamtimes.

- *Responsabilità progettuali:*
  - sviluppo di nuovi polimeri per applicazioni fotovoltaiche (progetto regionale “SISTER”, grant di 19.000 €, chiuso con successo; vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli);
  - setup di un laboratorio chimico interno a Sincrotrone (Progetto interno Sincrotrone, budget of 34.000 €, chiuso con successo; vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli);
  - sviluppo di striscie sensibili basate su fotodiodi organici per la domotica (progetto regionale “EasyHome”, grant per Sincrotrone Trieste of 137.000 €, chiuso con successo; vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli);
  - sviluppo e caratterizzazione di compositi polimeri/nanoparticelle/nanotubi per applicazioni prostetiche (progetto nazionale “Procerpol”, vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli);
  - Parzialmente responsabile per Sincrotrone nei seguenti progetti:
    - fabricazione di OLEDs basati su polimeri (progetto regionale "NANOBIOSOLED", sotto il programma POR-FESR, fondi per Sincrotrone di circa 850.000 €, amministrati personalmente circa 50.000 €; chiuso con successo);
    - fabbricazione e caratterizzazione di celle fotovoltaiche dye-sensitized basate su nuovi coloranti (progetto europeo “ERG”, sotto la Technology Platform JU-ENIAC/AENEAS, chiuso con successo; vedere la sezione "Raccolta Fondi e Finanziamenti" per i dettagli).

2003- Sett. 2008 – *Facoltà di Chimica Industriale, Università di Bologna, Bologna, Italia.*

- *Assegni di ricerca e contratti di ricerca* nel campo dei biosensori organici e del fotovoltaico organico. Principali attività svolte e risultati conseguiti:
  - Nel 2006 Responsabile per conto dell’Università di Bologna della sezione Materiali della Piattaforma Tecnologica Europea (ETP) SusChem. In particolare, incaricato di raccogliere ed organizzare contributi da diversi gruppi di lavoro provenienti da tutta l'Università (diverse Facoltà) nel campo della Scienza dei Materiali, e di raccordare questi contributi ed i relativi gruppi con le aziende europee e le università coinvolte nella piattaforma. In questo contesto, membro di quattro Working Groups della ETP (Energy, Information and Communication Technology (ICT), Quality of Life, Nanotechnology and Nanomaterials (NNMP)).
  - Vincitore dell'edizione 2006 di “Start Cup Emilia-Romagna" per una business idea legata al fotovoltaico polimerico (premio di 5.000 €).
  - In aggiunta ad altre attività, il networking personalmente sviluppato durante questo periodo ha portato tra il 2004 ed il 2006 al finanziamento, nel 2007, di due progetti nazionali, un PNR, “Fotoenergia”, nel campo del fotovoltaico polimerico (fondi recuperati per l'unità di UniBologna: ca. 85.000 €), e un PRIN, “Fabbricazione di FETs bio-organici via inkjet printing”, sull'utilizzo di transistor organici come sensori (fondi recuperati per l'unità di UniBologna: ca. 45.000 €).
  - Consulente in trasferimento tecnologico per l’Associazione Piccole e Medie Imprese (API) della provincia di Bologna
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2000-2003 – *Facoltà di Chimica Industriale, Università di Bologna, Bologna, Italia.*

- *Dottorato di Ricerca in Chimica Industriale*, su sintesi e caratterizzazione di polimeri coniugati

1996-2000 – *Azienda Privata, Bologna, Italia*

- Assistente al Direttore di Stabilimento in primaria azienda italiana di trasformazione materie plastiche (produzione tubi in PP e PE). Incaricato di organizzazione della produzione e della manutenzione linee di produzione e macchinari, logistica di approvvigionamento materie prime,

implementazione sistema qualità in reparto produzione, relazioni tecniche con fornitori macchinari e materie prime.

Esperienza didattica

- **2020-oggi**: Corso di Materiali e biomateriali per applicazioni odontoiatriche (4 CFU) per la Laurea Magistrale in Ingegneria Biomedica; Corso di Scienza dei Biomateriali (6 CFU) per la Laurea Triennale di Ingegneria Biomedica; Corso di Scienza e Tecnologia dei Materiali per il Master in Tecniche di fisiopatologia cardiocircolatoria e perfusione cardiovascolare (2 CFU); Corso di Materiali da costruzione per la Laurea Magistrale di Ingegneria delle Costruzioni (6 CFU); Corso di Materiali e Tecnologie di produzione per la Laurea triennale in Design (6 CFU).
- **2017-2020**: Parti di corso di Scienza e Tecnologia dei Materiali con lezioni su Nanotecnologie (Sensori, Elettrodi Trasparenti, Metodi di processo per la fabbricazione di films sottili) e Scienza dei Materiali generale (Diagrammi di fase di leghe, Materiali e processi per finestre intelligenti, Materiali termicamente isolanti per edifici, Trattamenti impermeabilizzanti per cementi e calcestruzzi), per un totale di 3 CFU in Scienza e Tecnologia dei Materiali (30 ore di didattica frontale) presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste.
- **2016-2017**: Parti di corso di Scienza e Tecnologia dei Materiali con lezioni su Nanotecnologie (Sensori, Elettrodi Trasparenti, Metodi di processo per la fabbricazione di films sottili) e Scienza dei Materiali generale (Diagrammi di fase di leghe, Materiali e processi per finestre intelligenti, Materiali termicamente isolanti per edifici, Trattamenti impermeabilizzanti per cementi e calcestruzzi), per un totale di 3 CFU in Scienza e Tecnologia dei Materiali (30 ore di didattica frontale) presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste. Serie di seminari nel campo dei Biomateriali (Polimeri Biocompatibili/Bioassorbibili, Organi Artificiali, Drug Delivery, Tissue Engineering), senza assegnazione di crediti formativi ufficiali, per un totale di ca. 20 ore, presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste.
- **2015-2016**: Parti di corso di Scienza e Tecnologia dei Materiali con lezioni su Nanotecnologie (Sensori, Elettrodi Trasparenti, Metodi di processo per la fabbricazione di films sottili) e Scienza dei Materiali generale (Diagrammi di fase di leghe, Materiali e processi per finestre intelligenti), per un totale di 3 CFU in Scienza e Tecnologia dei Materiali (30 ore di didattica frontale) presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste. Serie di seminari nel campo dei Biomateriali (Polimeri Biocompatibili/Bioassorbibili, Organi Artificiali, Drug Delivery, Tissue Engineering), senza assegnazione di crediti formativi ufficiali, per un totale di ca. 20 ore, presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste. Docenza esterna presso la "Summer School on Energy "Giacomo Ciamician", organizzata a Sesto Val Pusteria dal Dip.to di Ingegneria e Architettura dell'Università di Trieste (2 ore).
- **2014-2015**: Parti di corso di Scienza e Tecnologia dei Materiali con lezioni su Nanotecnologie (Sensori, Elettrodi Trasparenti) e Scienza dei Materiali generale (Diagrammi di fase di leghe, Materiali e processi per finestre intelligenti), per un totale di 3 CFU in Scienza e Tecnologia dei Materiali (circa 30 ore di didattica frontale) presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste. Serie di seminari nel campo dei Biomateriali (Polimeri Biocompatibili/Bioassorbibili, Organi Artificiali, Drug Delivery, Tissue Engineering), senza assegnazione di crediti formativi ufficiali, per un totale di ca. 20 ore, presso il Dip.to di Ingegneria e Architettura dell'Università di Trieste.
- **2008-2012**: serie di seminari presso il Dip.to di Ingegneria dell'Università di Trieste sui temi del fotovoltaico organico e dell'autoassemblaggio di nanostrutture, per un totale di ca. 8 ore.
- Docenza esterna presso la "Summer School on Energy "Giacomo Ciamician", organizzata a Sesto Val Pusteria dal Dip.to di Ingegneria e Architettura dell'Università di Trieste (2 ore).
- **2007-2008**: Professore a contratto per un modulo (36 ore) di “Scienza e Technologia dei Materiali Polimerici” (A.A. 07-08) presso la Facoltà di Ingegneria dell’Univ. di Bologna, per un Master in Tecnologie per la Sensoristica.
- **2005-2006**: Professore a contratto (Tutor) per il Corso di Fondamenti di Chimica della Facoltà di Ingegneria, Univ. di Bologna Bologna (45 ore); Professore esterno in “Master in Produzione, Utilizzo e Gestione di Energia da Fonti Rinnovabili”, Università di Camerino con seminario (2 ore) sul fotovoltaico organico.
- **2004-2005**: Professore esterno in “Master in Produzione, Utilizzo e Gestione di Energia da Fonti Rinnovabili”, Università di Camerino, con seminario (2 ore) sul fotovoltaico organico.

Attività accademica

Pubblicazioni

Autore o co-autore di 64 articoli su riviste internazionali referate (alcune non coperte da Scopus); al 20/10/24, h-index = 20; n° citazioni: 1348); 1 capitolo di libro; 1 brevetto europeo concesso, 1 brevetto italiano concesso, 1 marchio registrato, 2 domande PCT esaminate con search report favorevole (richiesta non estesa per motivi economici), 2 richieste di brevetto italiano sottomesse con search report favorevole ma non registrate; più di 90 contributi (orali e poster) a conferenze internazionali (di cui 62 contributi orali, di cui una decina Invited).

Supervisione di studenti e Post-Docs

Durante il periodo all'Università di Bologna (2003-2008) ha supervisionato sei studenti di Laurea Quinquennale e tre studenti di laurea triennale, in Chimica Industriale o Ingegneria Elettronica. I progetti di laurea avevano come tema la fabbricazione di biosensori, la deposizione inkjet di molecole/polimeri conduttive/semiconduttive, e "nasi elettronici" a base di polimeri come elementi sensibili, per applicazione in monitoraggi industriali e ambientali. Come Senior Researcher in Sincrotrone Trieste, ha supervisionato una tesi magistrale (Laurea in Fisica, in collaborazione con l'Università di Bologna) sul tema dell'anisotropia elettronica degli OSSCs, due tesi magistrali sul tema di dispositivi fotovoltaici basati su quantum dots (in collaborazione con l'Università di Trieste), una tesi triennale (4 mesi di lavoro, Laurea di Ingegneria Elettronica) su caratterizzazione impedenziometrica di dispositivi fotovoltaici organici, un contrattista di ricerca su un progetto votato alla sintesi e caratterizzazione di nuovi polimeri per applicazioni fotovoltaiche, un altro contrattista su temi legati a sensori ottici di prossimità basati su LED polimerici, un PostDoc che ha lavorato su studi spettroscopici su OSSCs, ed un Dottorato di Ricerca (ottenuto nel Marzo 2014) sul tema delle dye-sensitized solar cells. Come Ricercatore a T.D. all'Università di Trieste, nel periodo dal 2014 ad oggi ha supervisionato/co-supervisionato nove tesi triennali e tre magistrali, più due Dottorati (PhD School of Nanotechnology) e due Assegnisti di Ricerca, su temi che vanno da biomateriali nanostrutturati per ingegneria tissutale a celle fotovoltaiche perovskitiche a OSSCs a sensori di gas basati su polimeri semiconduttori nanostrutturati, fino ad arrivare a nanocompositi per applicazioni navali. Ha supervisionato, tra il personale menzionato, anche studenti stranieri (Polonia, Turchia, India): una studentessa polacca per ca. quattro mesi per un'internship, uno studente polacco per un periodo all'estero di tre mesi durante il suo dottorato, ed una studentessa turca per la sua laurea magistrale, condotta integralmente sotto il programma Erasmus presso i laboratori UniTS gestiti da AFM. Ha inoltre supervisionato due PostDoc indiani, per un periodo complessivo di ca. tre anni, e co-supervisionato una studentessa di Dottorato dell'Istituto di BioRobotica della Scuola di Studi Superiori Sant'Anna di Pisa.

Durante il periodo all'Università di Chieti-Pescara ha supervisionato una dozzina di tesi triennali, e sta attualmente supervisionando un dottorando sul tema dei nanocompositi per l'isolamento termico. Sta inoltre co-supervisionando un assegnista di ricerca presso l'Università di Trieste nell'ambito di un PRIN coordinato dall'Università di Trieste per il quale funge da responsabile dell'unità di ricerca di Chieti-Pescara; è inoltre in partenza, sempre nell'ambito di detto PRIN, dal 1° Novembre, un ulteriore assegnista di ricerca che sarà supervisionato direttamente da AFM.

Revisione di articoli/progetti

- E' revisore di articoli per riviste del settore di Scienza dei Materiali, come Nature Photonics, Advanced Materials, Advanced Functional Materials, Advanced Science, Angewandte Chemie International Edition, Organic Electronics, Physica Status Solidi, Materials Science and Engineering C, Molecules, Sensors, Nanomaterials.
- Nel 2014 ha svolto attività di valutatore nel programma EU H2020-NMP-PILOTS-2014, valutando 8 differenti progetti di ricerca.

Nel 2011, 2012-2013, 2015, 2017 ha svolto attività di valutatore nel programma New Eurasia Foundation, nelle more del decreto n° 220/2010 della Federazione Russa, "Measures to Attract Leading Scientists to Russian Educational Institutions", per un totale di dodici differenti progetti di ricerca.

Ha anche svolto attività di valutazione come Rapporteur per la Commissione Europea nel 2010.

Altre attività accademiche

Nell'Anno Accademico 2020-2021 cura, su delega dipartimentale, la preparazione della richiesta per l'attivazione della Laurea Magistrale in Ingegneria Biomedica presso il Dipartimento di Ingegneria e Geologia dell'Università di Chieti-Pescara. Il Corso di Laurea è stato attivato con successo (conta al momento due curricula) e AFM ne è il Presidente.

Nell'Anno Accademico 2018-2019 è Co-Organizzatore del Master di secondo livello in Robotics del Dipartimento di Ingegneria e Architettura dell'Università di Trieste, e Coordinatore Scientifico dello stesso Master (http://masterinrobotics.units.it).
Nel 2015 ha co-organizzato uno dei simposi della conferenza internazionale EMRS 2015 (Symposio Q: "Organic semiconducting single crystals: from fundamentals to advanced devices"), tenutosi a Lille (Francia) nel Maggio 2015.
E' stato membro del Collegio dei Docenti della PhD School of Nanotechnology (http://www.nanotech.units.it/default.aspx) dell'Università di Trieste nel periodo 2010-2013.
Nel 2013 è stato Rappresentante per la Sincrotrone Trieste nel Management Board di Alliance for Materials Italia (A4MIt), una piattaforma tecnologica italiana avente lo scopo di promuovere la cooperazione tra industria e accademia nell'ambito dei materiali. Ha rappresentato Sincrotrone Trieste anche nella contribuzione all'edizione 2012 delle Priorità Tecnologiche Industriali dell'Associazione Italiana Ricerca Industriale (AIRI), VIII edizione, nella sezione "Energia".
Ha anche ottenuto, nel periodo 2009-2018, un totale di 12 beamtimes alla Sincrotrone Trieste per svariate investigazioni scientifiche (i beamtimes sono attribuiti sulla base di peer reviews internazionali delle proposte presentate alla Sincrotrone Trieste, con cadenza semestrale).

Formazione e Training

2012 – Tutorial su Organic Semiconductor Crystals svolto al MRS Fall Meeting (Boston, USA), 25/11/2012
2011 – Tutorial su Organic Semiconductor Crystals svolto al MRS Fall Meeting (Boston, USA), 27/11/2011
2011 – Corso pratico di Project Management (Marzo, 4 giorni) tenuto alla Sincrotrone Trieste da un insegnante certificato dal PMI-Project Management Institute.
2007 – Scuola Nazionale di Introduzione alla Fotochimica, Bologna (Italia).
2003 – Dottorato di Ricerca in Chimica Industriale, Fac. di Chimica Industriale, Univ. di Bologna.
2000-2003 – Vari workshops e scuole nel campo dell'Elettronic/Optoelettronica Organica, Scienza dei Polimeri, Gestione della Proprietà Intellettuale. Nel 2001 Visiting fellow (tre mesi) alla Chalmers University of Technology, Goteborg (Svezia).
2001 - Abilitazione dell'esercizio alla professione di Chimico
1995-1996 – Corso di Perfezionamento (Master) in Direzione d'Impresa, Scuola di Gestione d'Impresa, Fac. di Ingegneria, Univ. di Bologna, Italia.
1995 – Laurea in Chimica Industriale in sintesi organica e caratterizzazione, Fac. di Chimica Industriale, Univ. di Bologna.

Networks attivi e collaborazioni, aggiornato a Settembre 2020

Collaborazioni scientifiche feconde ed attive sono state stabilite negli anni sia in Italia che all'estero.
In **Italia** sono attive collaborazioni con i Dip.ti di Ingegneria Elettronica, di Fisica e di Chimica dell'**Università di Bologna**; Dip.to di Ingegneria Elettronica dell'**Università di Cagliari**; **Istituto di BioRobotica** della **Scuola di Studi Superiori Sant'Anna di Pisa**; con l'azienda **Marinoni SpA** di Genova (GE); con **l'Istituto Officina dei Materiali** del CNR (CNR-IOM) (Trieste); con l'**Istituto ISMN-CNR** di Bologna. Negli anni precedenti sono state svolte collaborazioni con **UNINOVA** (Portogallo), **CEA-LITEN** (Francia), **EURORAD S.A.** (Francia), **TAGSYS Europe SaS** (Francia), **NANOGRADE Ltd.** (Svizzera), **F.lli Budai srl** (Italia).

Raccolta fondi e finanziamenti

2023 ● Finanziamento di un PRIN2022 ("Flexpole", codice "20227YNHEB"), focalizzato su cristalli organici elastici per applicazioni optoelettroniche, per un totale di ca. 187.000 €, coordinato dall'Università di Trieste (Prof. S. Geremia). Responsabile dell'unità di Chieti-Pescara, per un budget assegnato di ca. 87.000 €.

2021 ● Finanziamento di ca. 60.000 € da parte della Regione Abruzzo per un dottorato PON centrato sulla realizzazione di nanocompositi per isolamento termico.

2017 ● Progetto regionale Friuli Venezia-Giulia "ISOLCOL", programma POR-FESR (costi riconosciuti all'Università di Trieste: ca. 175 K€, di cui ca. 140 K€ sono coperti dalla Regione; costi totali di progetto ca. 470 K€). Tema del progetto: preparazione e test di nanocompositi per applicazioni navali. Durata: un anno. Consorzio composto da due aziende private (SMEs) e dall'Università di Trieste, con FINCANTIERI come end user dei prototipi sviluppati durante il progetto. Ruolo personale nel progetto: Responsabile

dell'Unità di Ricerca UNITS, WP Leader e consulente tecnico/scientifico per il Coordinatore di Progetto (una delle due aziende). Stato: chiuso con successo.

2016 ● Grant di 5.000 € da un'azienda privata italiana per esplorare il potenziale di aerogel di silice modificati come materiali termicamente isolanti nel settore navale.

2015 ● Ottenimento di co-finanziamento di ca. 23.000 € dall'Università di Trieste come contributo per un Assegno di Ricerca sul tema di cristalli organici singoli semiconduttori.

2014 ● Vincitore di un totale di 40 ore di servizi di consulenza per aziende start-up nel contesto del concorso "Campus d'Impresa", gestito da AREA Science Park (Basovizza, Trieste).

2013 ● Progetto europeo “iFLEXIS”, sotto il programma FP7-ICT (finanziamento ricevuto da UNITS ca. 430 k€, finanziamento totale del progetto ca. 3.8 M€). Tema del progetto: sviluppo di rivelatori di raggi X innovativi, su larga area e su substrati flessibili, basati su semiconduttori organici. Durata: tre anni. Consorzio composto da sette partners, incluse aziende e istituzioni di ricerca pubbliche. Ruolo personale: Responsabile dell'Unità di Ricerca UNITS, WP Leader. Status: chiuso con successo, con una speciale menzione dei review officers per l'ottimo lavoro svolto dal WP coordinato dal sottoscritto. Il progetto ha anche vinto il premio come miglior dimostratore realizzato con finanziamenti pubblici della OE-A Competition 2017 (competizione organizzata dalla associazione europea per l’elettronica organica).

2011 ● Finanziamento interno Sincrotrone per brevettare e sviluppare nuovi sensori per radiazioni ionizzanti a base di cristalli organici (2.5 K€ più risorse umane dedicate).

2010 ● Progetto italiano "Procerpol", sotto il programma “Industria 2015” del Ministero Attività Produttive (ca. 222 K€ di contributi assegnati a Sincrotrone Trieste, su un valore totale di progetto di ca. 6 M€). Tema del progetto: Nuovi materiali nanostrutturati per prostetica ortopedica biocompatibile. Durata: tre anni. Consorzio di progetto composto da sette partners, incluse aziende private e istituzioni di ricerca pubbliche. Consorzio guidato da un'azienda privata (LIMA SpA, Italia). Ruolo personale: Responsabile dell'Unità di Ricerca Sincrotrone Trieste, WP Leader. Status: partito ufficialmente il 1/10/2012, ma abortito durante il 2014 a causa del ritiro dell'azienda capofila.

● Progetto regionale Friuli Venezia-Giulia "EASYHOME", sotto il programma POR-FESR (ca. 137 K€ di finanziamento per Sincrotrone Trieste, con valore totale di progetto di ca. 1.2 M€). Tema del progetto: fabbricazione di nuove interfacce utente intelligenti basate sull'uso di elettronica stampabile (inclusi semiconduttori organici) per applicazioni domotiche user-friendly. Durata: due anni. Consorzio composto da otto partners incluse aziende private e istituzioni di ricerca pubbliche, guidato da un'azienda privata (Centro Ricerche Plastoptica – CRP srl, azienda controllata da Centro Ricerche FIAT SpA, Italia). Ruolo personale: Responsabile dell'Unità di Ricerca Sincrotrone Trieste. Status: chiuso con successo.

● Co-responsabile del progetto Europeo ERG, sotto il programma JU-AENEAS (150 K€ di finanziamento per Sincrotrone Trieste, valore totale del progetto di ca. 18.6 M€), in partnership con aziende e centri di ricerca europei. Tema del progetto: Energia per una società più pulita. Durata: tre anni. Consorzio composto da 38 partners, comprendenti aziende e istituzioni di ricerca pubbliche, guidato da ST Microelectronics (Italy). Ruolo personale: Key Researcher (co-responsabile per il progetto all'interno di Sincrotrone Trieste; in particolare responsabile per il tema di nuove celle fotovoltaiche dye-sensitized; budget amministrato personalmente: 57 K€). Status: chiuso con successo.

2009 ● Vincitore di un Grant di 19.000 € per un progetto di 9 mesi su celle fotovoltaiche polimeriche finanziato da Area Science Park Trieste (Progetto SISTER). Ruolo personale: responsabile di progetto. Status: chiuso con successo.

● Assegnatario di un finanziamento interno di Sincrotrone Trieste di 34.000 € per la risistemazione di un laboratorio chimico negli edifici della Sincrotrone Trieste. Status: chiuso con successo.

2007-2008 ● Rinnovo dell'Assegno di Ricerca del 2006 (vedere voce corrispondente poco sotto) per ricerca su dispositivi bioelettronici (durata prevista di un anno; Assegno interrotto dopo dieci mesi a causa dello spostamento dall'Università di Bologna alla Sincrotrone Trieste).

2006 ● Vincitore di un Assegno di Ricerca di 22 mesi per ricerca su dispositivi bioelettronici.

● Membro del team vincitore della Start Cup 2006 Emilia-Romagna, Business Plan competition gestita dal Consorzio Spinner (emanazione della Regione Emilia-Romagna); premio in denaro di 5.000 €.

2004 ● Co-assegnatario di un grant di 10.000 € erogato dal Consorzio Spinner (www.spinner.it) per un progetto di creazione d'impresa legato a celle fotovoltaiche plastiche (fase di start-up). Risultati del progetto: a cause di vincoli esterni la start-up non è potuta partire.

● Co-assegnatario di un fondo di 14.000 € assegnato da un gruppo di sette Comuni della Provincia di Bologna per uno studio di fattibilità su grandi impianti fotovoltaici gestiti con modalità consortili.

2003 ● Co-assegnatario di un grant di 45.000 € erogato dal Consorzio Spinner (www.spinner.it) per un progetto di creazione d'impresa legato a celle fotovoltaiche plastiche (sviluppo dell'idea innovativa).

2001 ● Vincitore del Fondo per Giovani Ricercatori dell'Università di Bologna. Grant di 5.000.000 L. (ca. 2.500 €).

Altre attività

- ***Presidente e co-fondatore dell'Associazione Italiana per la Ricerca (AIR)***, fondata nel 2007 e chiusa nel 2013. La missione di AIR era di promuovere la ricerca come volano economico e di portare un cambiamento culturale nella società italiana per fornire riconoscimento e valore alle eccellenze scientifiche, specialmente quelle dei giovani che approcciano la ricerca scientifica.
- ***Presidente dell'Associazione Dottorandi e dottori di ricerca Italiani (ADI)*** (ADI, www.dottorato.it) da Luglio 2005 a Giugno 2007. Sotto la sua guida l'ADI ha concluso accordi quadro ufficiali con la Conferenza dei Rettori delle Università Italiane (CRUI) per migliorare la qualità dei corsi di Dottorato offerti dalle Università; con i Giovani Imprenditori di Confindustria per aumentare il valore del Dottorato nella carriera industriale/privata; e con Alma Laurea, consorzio nazionale delle Università focalizzato sul Job Placement, per promuovere la visibilità del Dottorato di Ricerca nel panorama aziendale italiano. Ha anche organizzato ed avviato la campagna nazionale per aumentare la borsa di Dottorato dagli allora 800 €/mese (netti) agli attuali 1000 €/mese (netti), che ha raggiunto il suo obiettivo nel 2008.
- ***Membro del Board dei Giovani Chimici della Società Chimica Italiana*** per gli anni 2005 e 2006 (Presidente della Commissione finanziamenti).
- ***Consulente*** **tecnico-scientifico** per Piccole e Medie Imprese dal 2006 to 2008 nel campo dell'innovazione applicata ai processi industriali.
- ***Candidato alla Presidenza della Regione Autonoma Friuli Venezia Giulia*** per le elezioni regionali 2018 con il MoVimento 5 Stelle, ottenendo circa il 12% dei voti totali. In questa veste ha avuto modo di sviluppare competenze in ambito di gestione della comunicazione politica e istituzionale, del coordinamento di gruppi di volontari impegnati in attività ben definite su territori estesi (con numerosità dei volontari variabile da poche decine a diverse centinaia di persone), gestione e risoluzione dei conflitti interni ad un'organizzazione, raccolta fondi per campagne politiche e di opinione, organizzazione eventi.

Trieste, 1/11/2024

Lista completa delle pubblicazioni di Alessandro Fraleoni Morgera

RP - Research Papers

(* = corresponding author; IF = Journal Impact Factor, Thomson)

PLEASE NOTE: in 2002 I changed my family name from "Fraleoni" to "Fraleoni Morgera". To find all my publications in Scopus or other search engines it is needed to look for the surname "Fraleoni", otherwise the papers from 1999 to 2003 will not be covered.

RP1) A. Fraleoni, P. Zanirato, "Boron trifluoride-assisted reactions of 1-benzothiophen-3(2H)-one with various ketones: A convenient entry to 2-methylene-1-benzothiophen-3(2H)-one and/or 6H-di[1]benzothieno[3,2-b:2,3-e]pyran derivatives", *J. Chem. Res. (S)*, **1999**, 542-543 (IF 2000 - first year available: 0.522)

The title compounds are obtained in moderate to high yields by BF3- assisted reaction of 1-benzothiophen-3(2H)-one with nine ketones in diethyl ether at room temperature; the relative amounts of pyran 1 and ylidene 2 prove to be dependent upon electronic and steric factors.

RP2) C. Della Casa, A. Fraleoni, P. Costa Bizzarri and M. Lanzi, "New 3-alkylthiophene copolymers functionalized with a NLO chromophore", *Synth. Met.*, **2001**, 124, 467-470 (IF 2001: 1.158)

The soluble polythiophenes functionalized with a non-linear optical chromophore were prepared using copolymerization. The microstructure and the composition of the copolymers was determined through nuclear magnetic resonance spectroscopy. Two different types of solvent effects were identified. The first effect was on the conformation of the thiophene backbone and the other was on the electronic transition energy of the azobenzene unit.

RP3) C. Della Casa, A. Fraleoni, P. Costa Bizzarri, M. Lanzi, L. Paganin, "Synthesis and characterization of poly(3-alkylthiophenes) with NLO chromophoric groups in side chains", *Macromol. Symp.*, **2002**, 180, 217-221 (IF 2002: 0.758)

Polythiophene copolymers containing alkyl side chains of different length and partially functionalized with chromophoric groups have been synthesized by FeCl3 oxidative coupling of 3-alkylthiophenes and functionalized 3-alkylthiophenes. Composition, molecular weigth and configuration of the soluble fraction of the copolymers have been investigated and some structure-property correlations have been evidenced.

RP4) M. Lanzi, L. Paganin, P. Costa-Bizzarri, C. Della-Casa, A. Fraleoni, "Facile synthesis of soluble multifunctional polyalkylthiophenes", *Macromol. Rapid Comm.*, **2002**, 23, 630-633 (IF 2002: 2.901)

A method of synthesis leading to poly(3-alkylthiophene)s with two different functional groups in the side chain, one of which is an NLO-active chromophore, has been developed. This method, based on the post-functionalization of a reactive homopolymeric precursor, permits to prepare different polyfunctional polymers that are fully soluble in the most commonly used organic solvents. The procedure is very easy to perform, cost-effective, highly versatile and reproducible.

RP5) M. Lanzi, P. Costa Bizzarri, C. Della Casa, L. Paganin, A. Fraleoni, "Synthesis, characterization and optical properties of a regioregular and soluble poly[3-(10-hydroxydecyl)-2,5-thienylene]", *Polymer*, **2003**, 44, 535-545 (IF 2003: 2.340)

The preparation of a regioregular trimethylsilanyloxydecyl 3-substituted polythiophene and its conversion to the corresponding hydroxydecyl polymer, which is soluble in common organic solvents, is described both in solution and in film. The chromic behaviour of the hydroxy functionalized polymer was investigated by UV-vis spectroscopy in different solvent/non-solvent mixtures and in the solid state by exposing the polymer adsorbed on hydroxylic matrices to methanol vapours.

RP6) A. Fraleoni-Morgera*, C. Della Casa, P. Costa Bizzarri, M. Lanzi, "Investigation on Different Procedures in the Oxidative Copolymerization of a Dye-Functionalized Thiophene with 3-Hexylthiophene", *Macromolecules*, **2003**, 36, 8617-8620 (IF 2003: 3.621)

For the purpose of preparing materials for nonlinear optics applications, a 3-ethylthiophene bearing an NLO-active chromophoric group as a substituent at the end of the ethylic chain was copolymerized with 3-hexylthiophene. Different FeCl3-based oxidative polymerization conditions in solvents such as CH3NO2 and CCl4 and their effects on the copolymers characteristics and solubility in CHCl3 (i.e., the copolymer's soluble fraction) were examined. This work allowed to achieve a satisfactory chloroform-soluble fraction of the copolymer, still containing a notable amount of NLO-active group, and to tune to some extent the main characteristics of the copolymer; moreover, the behavior of the monomers-solvent-oxidant system was investigated.

RP7) L. Setti, C. Piana, S. Bonazzi, B. Ballarin, D. Frascaro, A. Fraleoni-Morgera, S. Giuliani, “Thermal Inkjet Technology for the Microdeposition of Biological Molecules as a Viable Route for the Realization of Biosensors”, *Anal. Lett.*, **2004**, 37, 1559-1570 (IF 2004: 1.165)

Recent progress in inkjet printing of parts of biosensors are highlighted, with particular reference to the printing of biologically active molecules. We describe a system constituted by a thermal inkjet printer, adapted to layering a bidimensional array of dots [701 x 701 dots per inch] on solid supports. The printer was used to depose a Î²-galactosidase (GAL)-containing ink on a polyester sheet, with dots obtained from 10 pL drops, each drop containing in turn 6 pg of enzyme. The activity of GAL after the preparation was determined using a colorimetric probe (Brilliant Blue FCF). The activity loss of the microdeposed enzymes was found to be around 15%, showing that the 2 μsec-lasting thermal shock experienced by the biomolecule into the printhead nozzle affects to a lesser extent the activity of the thermal inkjet deposited enzyme. In conclusion, the most recent findings of our group in this line are depicted, and a view of possible future developments of the " biopolytronics" field is outlined.

RP8) B. Ballarin, A. Fraleoni Morgera, D. Frascaro, S. Marazzita, C. Piana, L. Setti, “Thermal Inkjet microdeposition of PEDOT:PSS on ITO-Coated Glass and characterization of the obtained film”, *Synth. Met.*, **2004**, 146, 201-205 (IF 2004: 1.278)

In view of direct inkjet printing of low-cost sensors, we describe here the thermal printing of a thin film of a commercially available conjugated polymer (poly(3,4-ethylenedioxythiophene):polystyrene sulfonic acid, PEDOT:PSS). The printed film has been investigated by optical microscopy, AFM and cyclic voltammetry. The results have been compared to the ones obtained for a continuous film of the same polymer deposed by spin-coating. No appreciable differences were noted between the electrochemical behaviour of the two samples, indicating that the thermal printing of the polymer did not alter appreciably the material properties. Our findings indicate that the thermal printing route may be then a good alternative for the controlled deposition of thin films of conjugated polymers.

RP9) A. Fraleoni-Morgera*, S. Marazzita, D. Frascaro, L. Setti, “Influence of a non-ionic surfactant on the UV–vis absorption features of regioregular head-to-tail poly(3-hexylthiophene) in water-based dispersions”, *Synth. Met.*, **2004**, 147, 149-154 (IF 2004:1.278)

The use of a non-ionic surfactant for preparing a stable aqueous dispersion of regioregular head-to-tail poly(3-hexylthiophene) (R-P3HT) is described. The spectral features of a THF solution of R-P3HT dispersed in water are investigated by means of UV-vis absorption spectroscopy. A clear difference between the classical solvatochromic phenomenology and the behaviour of the realized polymer/THF/water/surfactant system is observed, pointing to interactions between the polymeric alkylic side chains and the surfactant hydrophobic tail. From a technological point of view, the presented water-based dispersions, reducing use of toxic organic solvents, may be an interesting and environmentally friendly approach to the processing of conjugated polymers.

RP10) A. A. Apostoluk, L. Rocha, C. Fiorini-Debuisschert, C. Sentein, P. Raimond, L. Setti, A. Fraleoni-Morgera, J.-M. Nunzi, “Semiconducting dye-functionalised poled polymers for photovoltaic applications”, *Mater. Sci. Poland*, **2004**, 22, 397-406 (IF 2005 -first year available: 0.571)

In order to build efficient single-layer polymer photovoltaic devices, the realization of an equivalent distributed p-n junction is proposed. Orientation in the initially centrosymmetric material is obtained by ordering polar molecules contained in a polymer matrix with a DC field. The molecular rectification effect induced in an oriented polymer film improves the efficiency of polymeric semiconducting devices like solar cells. The first experiments were conducted with a poly(methylmethacrylate) (PMMA) matrix containing azo-dye compounds (such as the Disperse Red 1, DR1) as the polar molecules, grafted onto the chains of the polymer backbones. Although this material allows for high orientation efficiencies, it is not adapted for photovoltaic applications, since DR1-MMA has very poor semiconducting properties due to the dielectric nature of PMMA. Organic semiconductors are uncommon and it is difficult to find an appropriate polymer system. We present preliminary results obtained for two intrinsically semiconducting and dye-functionalised polymer systems which may be found applicable in the fabrication of organic photovoltaic solar cells using the concept of polar molecular ordering. We use polymer systems with a covalent bond between the dye

molecule and conjugated backbone to obtain a high dye content and to avoid phase separation problems. To achieve the largest stable molecular polar orientation possible and to optimise the electric field stored in an oriented structure, we studied the orientation parameters of samples, i.e., the orientation field, temperature, poling duration, and cooling conditions.

RP11) L. Setti, A. Fraleoni-Morgera, B. Ballarin, A. Filippini, D. Frascaro, C. Piana, “An amperometric glucose biosensor prototype fabricated by thermal inkjet printing”, *Biosens. Bioel.*, **2005**, 20, 2019-2026 (IF 2005: 3.463)

The prototype of an amperometric glucose biosensor was realized by thermal inkjet printing using biological and electronic water-based inks, containing a glucose oxidase (GOD) from Aspergillus niger and the conducting polymer blend poly(3,4-ethylenedioxythiophene/polystyrene sulfonic acid) (PEDOT/PSS), respectively. The biosensor was fabricated microdepositing PEDOT/PSS and GOD, in sequence, on ITO-glass, by a commercial inkjet printer, with the help of a commercial software. High density microdots matrices were so-realized, with a calculated resolution of about 221 x 221 dpi (dot per inch). By means of a rapid and easy assay it was demonstrated that no activity loss occurred upon the printing of GOD, despite of the use of a thermal printhead. The device was encapsulated in a semipermeable membrane of cellulose acetate, applied by dip-coating, in order to prevent dissolution of the enzyme and/or PEDOT/PSS in water. The preliminary response of the electrode was measured in an aqueous glucose solution in the presence of ferrocenemethanol (FeMeOH) as a mediator, and resulted linear up to 60 mM in glucose. The best sensitivity value achieved was 6.43 $\mu A\ M^{-1}\ cm^{-2}$ (447 $nA\ M^{-1}\ U^{-1}\ cm^{-2}$). The characteristics of the device, and the possible performance improvements have been analyzed and discussed. The reported findings indicate that inkjet printing could be a viable instrument for the easy construction of a working biosensor via direct digital design using biological and conductive polymer based inks. Such an approach may be seen as an example of "biopolytronics".

RP12) A. Fraleoni-Morgera*, C. Della Casa, P. Costa Bizzarri, M. Lanzi, A. Missiroli, “Completely Soluble Azo-Dye-Substituted Thiophenic Copolymers through Proper Molecular Design”, *Macromolecules*, **2005**, 38, 3170-3175 (IF 2005: 4.024)

Copolymerizations at various feed ratios between azo-dye-substituted thiophenes and 3-hexylthiophene under FeCl3-based oxidative conditions have been conducted. It is shown that when the molecular structure of the dye is properly designed, completely soluble copolymers, with molecular weigths ranging around 104 as Mn and dye-substituted monomer content up to 50% in a molar ratio, may be prepared, as well as a completely soluble homopolymer. In addition, the so-obtained polymers evidenced excellent filmability from a variety of solvents. The dye-substituted monomer content of the soluble copolymers has been assessed by 1H NMR analysis via a convenient choice of the reference signals. In the completely soluble copolymers the dye-substituted monomer content is well correlated to the feed within a range between 0 and 75% of dye-substituted unit in the feed, which corresponds to a 0-50% range in the copolymer composition, still conserving satisfactory molecular weights. Following these observations and analyzing the characteristics of the polymers, a lower reactivity of the dye-functionalized unit toward 3-hexylthiophene was evidenced in the used reaction conditions, and some hypotheses on this finding are presented.

RP13) C. Della-Casa, A. Fraleoni-Morgera, M. Lanzi, P. Costa-Bizzarri, L. Paganin, F. Bertinelli, L. Schenetti, A. Mucci, M. Casalboni, F. Sarcinelli, A. Quatela, “Preparation and characterization of thiophene copolymers with second order non-linear optical properties”, *European Pol. J.*, **2005**, 41, 2360-2369 (IF 2005: 1.765)

Azobenzene-substituted polythiophenes were prepared by copolymerization of 3-alkylthiophenes functionalized with an azo-chromophore and 3-alkylthiophenes as plastifying comonomers to improve solubility. Monomers with different oligomethylenic spacer and alkylic chain lengths were synthesized and copolymerized via FeCl3 oxidative polymerization. Polymer soluble fractions were characterized by 1H and 13C NMR, FTIR, UV-Vis spectroscopy, and GPC, DSC and TGA. Second-order non-linear optical properties were measured by the second harmonic generation technique

RP14) S. Cheylan, A. Fraleoni-Morgera, J. Puigdollers, C. Voz, R. Alcubilla, L. Setti, G. Badenes, “Comprehensive study of a novel thiophene-based polymer”, **2005**, *Proceedings of SPIE - The International Society for Optical Engineering*, 5937, 1-8 (IF not available)

We report here on the results of the characterization of a novel -OPhCN substituted thiophenic monomer, and of the obtained copolymers between the latter and the plastifying comonomer 3-hexylthiophene. The polymer evidences an excellent filmability from various organic solvents as well as an enhanced photoluminescence. The characteristics of the polymer were characterized by FTIR and XRD as well as photoluminescence. A bandgap of 2.0eV was obtained which corresponds to orange emission. Furthermore, a single layer organic device was fabricated and resulted in bright stable electroluminescence at room temperature. All of the results indicate that this polymer is a promising emissive material for application in light-emitting devices (LEDs).

RP15) S. Cheylan, A. Fraleoni-Morgera, J. Puigdollers, C. Voz, L. Setti, R. Alcubilla, G. Badenes, P. Costa-Bizzarri, M. Lanzi, "Study of a thiophene-based polymer for optoelectronic applications", *Thin Solid Films*, **2006**, 497, 16-19 (IF 2006: 1.666)

A thiophene-based conjugated polymer bearing a cyano group (-CN) as a side chain substituent was successfully synthesized. The polymer evidences an excellent filmability from various organic solvents as well as an enhanced photoluminescence. The polymer has been characterized optically (Fourier Transformed Infrared spectroscopy, absorption and photoluminescence) in solution and in film, while X-ray diffraction measurements (XRD) of thin films were performed to investigate its bulk morphological features. From the absorption edge of the spectrum of a thin polymer film, the optical band gap of the polymer is estimated to be 2.0 eV, which corresponds to orange emission. Furthermore, a single layer light emitting diode (LED) was fabricated. The device produced bright stable electroluminescence at room temperature. All of the results indicate that this polymer is a promising emissive material for application in polymeric LEDs.

RP16) A. Fraleoni-Morgera, P. Zanirato, "BF3.OEt2-promoted synthesis of acridines via N-aryl nitrenium-BF3 ions generated by dissociation of 2-oxo azidoarenes in benzene", *Arkivoc*, **2006**, 12, 111-120 (IF 2006: 0.800)

2-Oxo-substituted aryl azides such as 2-azidobenzenecarbaldehyde 1, 1-(2-azidophenyl)-1-ethanone 2 and (2-azidophenyl) (phenyl)methanone 3 react with benzene in the presence of BF3·OEt 2, mainly affording 9-substituted acridines via formal 2-anilino-oxobenzene-BF 3 complexes rapidly followed by intramolecular cyclo-dehydration at the activated carbonyl groups. Under the same conditions, 2-azidobenzoic acid 4 gives mainly 2-anilinobenzoic acid 4b together with trace amounts of the 9(10H)-acridinone 4a. On the other hand, 2-azidobenzenecarbonitrile 5 gives the 9-amino acridine 5a via a conjugated imine, which undergoes intramolecular cyclization. The BF3·OEt 2 promoted dissociation of aryl azides to aryl nitrenium ions is compared with those promoted by AlCl 3 or a strong protic acid (TFA/TFSA mixture).

RP17) Boscaleri, F. Castagnoli, F. Mencaraglia, .P. Rissone, F. Rotini, E. Ronchi, L. Setti, A. Fraleoni-Morgera, S. Cortiglioni, "Some technical solutions in stratospheric platform design devoted to protecting power sources from damages on landing", *European Space Agency Special Publication*, **2007**, 647 SP, 557-560 (IF not available)

Researchers in astrophysics and earth observation are still interested in balloon campaigns for making measurements outside the atmosphere. It is possible to trim a bit more from the ballooning costs by increasing the number of parts that can be reused, and by the careful design, the integration and the consolidation of a standard gondola apparatus (something like the mass production of cars). This paper will focus on one of the aspects capable of reducing costs, namely reusable power sources such as solar panels (SP) and fuel cells (FC) and how to protect them during the most difficult phases of the flight (take-off, landing). We will describe two possible ways of deploying and stowing a SP, and report the results of a thermal simulation aimed at ascertaining whether FC may be used in a stratospheric balloon environment.

RP18) L. Setti, A. Fraleoni-Morgera, I. Mencarelli, A. Filippini, B. Ballarin, M. Di Biase, "An HRP-based amperometric biosensor fabricated by thermal inkjet printing", *Sens. Act. B,* **2007**, 126, 252-257 (IF 2006: 2.331)

Direct inkjet printing of a complete and working amperometric biosensor for the detection of hydrogen peroxide, based on horseradish peroxidase (HRP), has been demonstrated. The device has been realized with a commercial printer. A thin layer of PEDOT:PSS, which was in turn covered with HRP, was inkjet printed on top of an ITO-coated glass slide. The active components of the device retained their properties after the thermal inkjet printing. The whole device has been encapsulated by means of a selectively permeable cellulose acetate membrane. The successful electron transfer between the PEDOT:PSS covered electrode and the enzyme has been demonstrated, and the biosensor evidenced very good sensitivity, in line with the best devices realized with other techniques, and a remarkable operational stability. This result paves the way for an extensive application of "biopolytronics", i.e. the utilization of conductive/semiconductive polymers and biologically active molecules to design bioelectronic devices using a common PC, and exploiting normal commercial printers to print them out.

RP19) S. Cheylan, H. J. Bolink, A. Fraleoni-Morgera, J. Puigdollers, C. Voz, I. Mencarelli, L. Setti, R. Alcubilla, G. Badenes, "Improving the efficiency of a light-emitting diode based on a thiophene polymer containing a cyano group", *Org. El.*, **2007**, 8, 641-647 (IF 2006: 3.418)

We report on the overall improvement of a single layer organic light-emitting diode device based on poly{[3-hethylthiophene]-co-3-[2-(p-cyano-phenoxy)ethyl]thiophene} or namely PTOPhCN. This polymer was recently developed by adding a cyano group as a side-chain substituent of the thiophenic backbone onto the

main polymer chain and showed promising results for light-emitting diode devices. Using an improved device layout, bright red electroluminescence was obtained at 4 V and showed a luminance of about 400 cd/m2 at 8 V with current densities in the order of 6000 A/m2.

RP20) P. Cardillo, L. Gigante, A. Lunghi, A. Fraleoni-Morgera, P. Zanirato, "Thermochemical evaluation of the intrinsic molecular reactivity of tosyl azide and 4,4'-diazidodiphenyl ether and sulfide, " *Cent. Eur. J. Energ. Mater.*, **2007**, 4, 81-93 (IF 2007: NA. IF 2012 (first available): 1.327. **NOTE**: THIS JOURNAL IS COVERED BY SCOPUS ONLY SINCE 2011 ONWARDS, THEREFORE THIS PARTICULAR PAPER IS NOT INDEXED BY SCOPUS)

The exothermic decompositions of the tosyl azide 1 and two diazides, 4,4'-diazidodiphenyl ether, (N3C6H4)2O 2 and 4,4'-diazidodiphenyl sulfide, (N3C6H4)2S (3), were studied theoretically using the CHETAH protocol, and experimentally using DSC, weight loss TGA-FTIR and C80-FTIR techniques. Numerical modelling and MS-spectroscopy were also performed to estimate the nature of the intrinsic molecular reactivity of the azides 1−3 as possible early stages of an oxidative self-heating process.

RP21) A. Fraleoni-Morgera, L. Giorgini, P. Zanirato, "[Arylazobenzene-BF3] dyes: Electronic absorption and NMR spectroscopic evidence for a novel class of dyes stable in aprotic solvents", *Dyes Pigments*, **2008**, 76, 394-399 (IF 2006: 1.909)

Treatment of a number of 4-substituted arylazobenzenes (-H, -Me, -CF3, -Br, -F and -OMe) with BF3·OEt2 in dry chloroform solution afforded chromophores that exhibited significant hyper- (log ε 4.41-4.60) and bathochromic shifts (λ_{max} 416-473) in electronic spectra, together with significant shifts in their 1H NMR and 13C NMR spectra, indicating the formation of novel chemical species. It is proposed that complexes are formed between the azo dyes and the Lewis acid, similarly to what happens for the well-known protic acids. The equilibrium constants (log K) of the proposed complexes have been calculated from the experimental data. Numerical modelling has also been performed to investigate the nature of the new systems, revealing a correlation between the electronic levels of the azo dye and the ones of the BF3·OEt2.

RP22) P. Cardillo, L. Gigante, A. Lunghi, A. Fraleoni-Morgera, P. Zanirato, "Hazardous N-containing systems: thermochemical and computational evaluation of the intrinsic molecular reactivity of some aryl azides and diazides", *New J. Chem.*, **2008**, 1, 47-53 (IF 2008: 2.942)

The exothermic decompositions of the tosyl azide 1, five substituted aryl monoazides 2-6 and two diazides: 1-azido-4-(4-azidophenoxy)benzene 7 and 1-azido-4-[(4-azidophenyl)sulfanyl]benzene 8 were studied experimentally using DSC, weight loss TGA-FTIR and C80-FTIR techniques, and theoretically using the CHETAH software. Numerical modelling and electron impact mass spectrometry (EI-MS) were also performed to investigate the nature of the intrinsic molecular reactivity of azides 1-8, and the possible early stage rate-controlling of an oxidative self-heating process. Significant data were obtained in the instances of 4-methylbenzenesulfonyl azide 1, 4-azido-1,1'-biphenyl-2,2-azido-1, 1,1'-biphenyl 3 and 1-azido-2-(trifluoromethyl)benzene 6. The most likely decomposition pathways of the azides are proposed to explain the observed thermal behavior.

RP23) L. Setti, A. Fraleoni-Morgera, I. Mencarelli, C. Bertoni, "Preliminary studies on the influence of surface morphological treatments of indium tin oxide on the performances of horseradish peroxidase-based biosensors", *Sensor Lett.*, **2008**, 6, 646-653 (IF 2008: 1.160)

The electrochemical treatment of Indium Tin Oxide (ITO) supported on glass slides was explored as a convenient route to create nanostructured electrodes, in an attempt to increase the performances of enzyme-based amperometric sensors. The effect of this treatment on the morphological, physical and optical properties of the ITO (SEM, AFM, WLI, X-ray analysis, UV-Vis transmittance) was investigated, as well as on its electrical characteristics (sheet resistance). Working bioelectrodes were fabricated on the nanostructured ITO layers, and the relations between the characteristics of the devices and the treatment effects on the ITO were analyzed and discussed. A positive effect of the electrochemically obtained nanostructures on the affinity of the organic layer for the electrons injected from the ITO surface was found.

RP24) B. Fraboni, R. DiPietro, A. Castaldini, A. Cavallini, A. Fraleoni-Morgera, L. Setti, I. Mencarelli, C. Femoni, "Anisotropic charge transport in organic single crystals based on dipolar molecules", *Org. Electron.* **2008**, 9, 974-978 (IF 2008: 3.590)

We studied the anisotropic charge transport properties of solution-grown organic single crystals based on a dipolar molecule (4-hydroxy-cyanobenzene) by field effect devices and by spectral photocurrent analyses. Optical excitation differently affects the flow of charge carriers along the two main planar crystal axes, altering the charge transport anisotropy induced by the molecular π-orbitals stacking. We attribute this

behaviour to the presence of an intrinsic molecular dipole and to its different orientation within the crystal lattice and we advance a hypothesis on the nature of the observed band of deep trapping states.

RP25) B. Fraboni, R. DiPietro, A.Castaldini, A. Cavallini, A. Fraleoni Morgera, L. Setti, I. Mencarelli, C. Femoni "Anisotropic charge transport in organic single crystals based on dipolar molecules" *Mat. Res .Soc. Symp. Proc.* **2008**, 1091, 37-43 (IF not available)

We studied the anisotropic charge transport properties of solution-grown organic single crystals based on a dipolar molecule 4HCB (4-hydroxy- cyanobenzene) by electrical transport measurements, current-voltage and space charge limited current (SCLC), and by X-ray diffraction analyses. Optical excitation differently affects the flow of charge carriers along the two main planar crystal axis, altering the charge transport anisotropy induced by the molecular π -orbitals stacking. We attribute this behaviour to the presence of an intrinsic molecular dipole and to its different orientation within the crystal lattice. The anisotropy of transport along the three crystallographic directions has been assessed by electrical characterization and correlated to the crystal molecular packing as determined by X-ray analyses.

RP26) B. Fraboni, C. Femoni, I. Mencarelli, L. Setti, R. DiPietro, A. Cavallini, A. Fraleoni-Morgera*, "Solution-grown macroscopic organic single crystals exhibiting three-dimensional anisotropic charge-transport properties", *Adv. Mater.* **2009**, 21, 1835-1839 (Journal main cover; IF 2009: 8.379).

A millimeter-sized solution grown (SG) organic single crystals based on 4-hydroxycyanobenzene (4HCB), which exhibited 3D anisotropic electrical properties along the three crystallographic axes a, b (constituting the main crystal flat face), and c (the crystal thickness), measured over several different samples, was reported. FET devices were used to estimate the directional carrier mobilities in the dark at room temperature and atmosphere along the two main axes. The mobility was determined by means of space charge-limited current (SCLC) measurements along the crystal thickness, axis c. X-ray diffraction analyses on some of the as-prepared crystals were conducted to verify the crystalline structure of the SG 4HCB crystals. The re-determination of the unit cell confirmed that the contacts were exactly aligned to the crystallographic axes a and b, and that the electrical stress did not alter the crystal lattice.

RP27) B. Fraboni, A. Fraleoni-Morgera, A. Cavallini, "Three-dimensional anisotropic electronic properties of solution grown organic single crystals measured by Space-Charge Limited Current (SCLC)" *Mat. Res .Soc .Symp. Proc.* **2009**, 1154, 63-68 (IF not available)

Organic single crystals offer the interesting and unique opportunity to investigate the intrinsic electrical behaviour of organic materials, excluding hopping phenomena due to grain boundaries and structural imperfections. Their structural asymmetry permits also to investigate the correlation between their three-dimensional order and their charge transport characteristics. Here we report on millimeter-sized, solution-grown organic single crystals, based on 4-hydroxycyanobenzene (4HCB), which exhibit three-dimensional anisotropic electrical properties along the three crystallographic axes a, b (constituting the main crystal flat face) and c (the crystal thickness), measured over several different samples. The carrier mobility was determined by means of space charge limited current (SCLC) and air-gap field effect transistors fabricated with 4HCB single crystals and the measured values well correlate with the structural packing anisotropy of the molecular crystal. A differential analysis of SCLC curves allowed to determine the distribution and the concentration of the dominant electrically active density of states within the gap.

RP28) B. Fraboni, A. Fraleoni-Morgera, A. Cavallini, "Three-dimensional anisotropic density of states distribution and intrinsic.like mobility in organic single crystals", *Org. Electron.*, **2010**, 11, 10-15. (IF 2010: 3.998)

Organic semiconducting molecules are receiving a large attention because of their potential applications, spanning from OLEDs to plastic photovoltaics to bio-chemical sensors. However, the electronic transport properties of these materials are still not fully understood, and organic single crystals (OSCs) may represent model materials for assessing the charge transport mechanisms, thanks to their high purity and molecular order. Here we show for the first time that solution-grown, millimiter-sized organic single crystals of 4-hydroxycyanobenzene (4HCB) possess a clear and reproducible three-dimensional anisotropy in their main transport parameters: (i) charge carrier mobility, (ii) distribution of the electronic density of states and (iii) deep traps energy and concentration, and we report intrinsic-like three-dimensional mobility values for these crystals. These findings demonstrate that the electronic spatial anisotropy of OSCs extends well beyond the carrier mobility, and open the way to the development of novel electronic device architectures based on the simultaneous exploitation of different electronic responses along the three spatial directions of the crystal.

RP29) A. Fraleoni-Morgera*, B. Fraboni, A. Cavallini, "Solution growth of single crystals of 4-hydroxycyanobenzene (4HCB) suitable for electronic applications", *J. Cryst. Growth*, **2010**, 312, 3466-3472 (IF 2010: 1.737)

Squared, platelet-like single crystals of 4-hydroxycyanobenzene (4HCB) have been grown from solutions based on ethylic ether and petroleum ether. Properly modifying the growth conditions, in terms of both solvent used for the growth and concentration of 4HCB in the starting solution, allowed one to tune the planar dimensions of the platelets in the range 2-6 mm, and their thickness in the range 150-600 μm. In this way samples well suited for desired practical manipulation and electronic measurements may be obtained. Moreover, lowering the growth temperature resulted in larger but still thin 4HCB crystals. The ability to tailor crystal thickness has allowed one to study their Space-Charge Limited Current (SCLC) behaviour along that dimension, showing that the so-contacted samples exhibit intrinsic-like bulk conduction behaviour, and are hence well suitable for electronic studies and applications.

RP30) A. Fraleoni-Morgera, "Fast Fabrication of Large Area, Nanostructured Arrays out of Polymers and Carbon Nanotubes by Wet-processing", *Small*, **2011**, 7, 321–325 (IF 2011:8.349)

A novel, fast, and low-cost method for fabricating large-area arrays of organic-material-based filamentary nanostructures is presented. The technique, auxiliary solvent-based sublimation-aided nanostructuring (ASB-SANS), only takes minutes and exploits a templating matrix easily removable by sublimation. Proof-of-concept patterns fabricated out of poly(methylmethacrylate) (PMMA) and carbon nanotubes (CNTs) are demonstrated.

RP31) A. Fraleoni-Morgera*, M.Tessarolo, A. Perucchi, L. Baldassarre, S. Lupi, B. Fraboni, "Polarized Infrared Studies on Charge Transport in 4-Hydroxycyanobenzene Single Crystals", *J. Phys. Chem. C*, **2012**, 116, 2563–2569 (IF 2012: 4.814)

4-Hydroxycyanobenzene (4HCB) semiconducting single crystals have been probed by polarized IR radiation under various conditions. Linearly polarized IR spectroscopy was found to be sufficient to identify the main crystal axes, provided that crystallographic and electrical analyses have been carried out at least once on the crystal. Moreover, a 2D anisotropic hydrogen bonding degree, which results to be higher along the axis a (one of the two planar axes), has been found. Static electrical polarization induces a rather large and anisotropic rotation of the 3D electric dipole vector of the crystal (p -), which increases its component along the axis a and decreases the one along b (the other planar axis). When the crystal is probed under actual charge transport conditions in a field effect transistor (FET) structure, the IR radiation is more effectively screened along axis a (which presents the highest carrier mobility) than along axis b.

RP32) B. Fraboni, A. Ciavatti, F. Merlo, L. Pasquini, A. Cavallini, A. Quaranta, A. Bonfiglio, A. Fraleoni-Morgera, "Organic semiconducting single crystals as next generation of low-cost, room-temperature electrical X-ray detectors", *Adv. Mater.*, **2012**, 24 2289-2293 (IF 2012: 14.829)

Direct, solid-state X-ray detectors based on organic single crystals are shown to operate at room temperature, in air, and at voltages as low as a few volts (see figure), delivering a stable and reproducible linear response to increasing X-ray dose rates, with notable radiation hardness and resistance to aging. All-organic and optically transparent devices are reported.

RP33) E. Capria,L. Benevoli, A. Perucchi, B. Fraboni, M. Tessarolo, S. Lupi, and A. Fraleoni-Morgera*, "Infrared Investigations of 4‑Hydroxycyanobenzene Single Crystals", *J. Phys. Chem. A* **2013**, 117, 6781−6788 (IF 2012: 2.771)

4-Hydroxycyanobenzene (4HCB) single crystals (SCs) and polycrystals (PCs) have been analyzed by means of both unpolarized and linearly polarized (LP) infrared (IR) beams. Most of the signals found at room temperature (298 K) were assigned to well-defined vibrational modes. Using an LP-IR beam and keeping the beam polarization aligned with either the a or the b crystal axis, anisotropic spectra of SCs were also attributed. The differences between the LP and unpolarized spectra of SCs are discussed in view of spatially anisotropic vibronic couplings between the benzenic Ï€ electrons and the molecular functional groups (FGs), with reference to the overall lattice arrangement and the polarizability of the FGs. In addition, signals suggesting the low-concentration presence of tautomers within the crystal were detected. LP-IR measurements of SCs in the temperature range between 298 and 120 K are also reported and discussed, with particular reference to the hydrogen-bonding- related functional groups of 4HCB, allowing the assignment of OH bending signals that were otherwise not clearly attributable and the inference of an anisotropic shrinking of the crystals. Overall, the presented results show that LP-IR spectroscopy is a valuable tool for noncontact, nondestructive characterization of organic semiconducting single crystals.

RP34) L. D'Arsié, M. Fanetti, C. Cepek, L. Casalis, P. Parisse, L. Gregoratti, M. Amati, G. Di Santo, E. Capria, A. Fraleoni-Morgera, E. Nicolini, A. Goldoni, "Tubular Sn-filled carbon nanostructures on ITO: Nanocomposite material for multiple applications", *Carbon*, **2013**, 65, 13-19 (IF 2013: 6.160)

Hollow carbon nanostructures filled by metallic Sn were fabricated by means of chemical vapor deposition on transparent Indium Tin Oxide (ITO). We found no need for catalytic particles, and the growth happens in the temperature range 820-940 K. Upon annealing in an oxygen atmosphere, the carbon skin could be burned out, leaving SnOx pillars on the ITO substrate. The electrical and optical properties of the grown Sn/C and SnOx nanopillars were characterized. This growth strategy is versatile and can suitably be adapted to different substrate materials, provided that ITO can be deposited and annealed at the temperature required for the formation of the nanostructures. The rational control of this simple growth process and the lack of deposited external catalysts allow the fabrication of ordered, possibly, vertically aligned nanopillars over large areas, with tunable morphological, electrical and optical characteristics. This approach is envisaged as a promising path to develop energy generation and storage electrodes or chemical sensors with improved efficiency.

RP35) A. Fraleoni-Morgera,* G. Palma, J. R. Plaisier, “Fast fabrication over large areas of P3HT nanostructures with high supramolecular order”, *RSC Adv.*, **2013**, 3, 15664-15669 (IF 2013: 3.708)

The fabrication of P3HT nanopatterns (lamellae and fibres) within a few minutes, in standard laboratory conditions (i.e., at room temperature and in air) and over areas as large as cm2, is reported. The nanostructures are prepared using a wet-processing method. A satisfactory control over the pattern topology (lamellae, hierarchically connected and parallel fibres, entangled but disconnected and quasi-parallel fibres, randomly oriented fibres) is obtained by simply changing one process parameter. UV-vis spectroscopy and X-ray diffraction analyses carried out over the so-fabricated structures evidence a very high degree of supramolecular organization of the polymeric chains. Such a degree of order is similar or even better than that of P3HT samples treated with thermal or solvent annealing procedures.

RP36) B. Fraboni, A. Ciavatti, L. Basirico’, A. Fraleoni-Morgera, “Organic semiconducting single crystals as solid-state sensors for ionizing radiation”, *Faraday Disc.*, **2014**, 174, 219-234 (IF 2014=4.606)

So far, organic semiconductors have been mainly proposed as detectors for ionizing radiation in the indirect conversion approach, i.e. as scintillators, which convert ionizing radiation into visible photons, or as photodiodes, which detect visible photons coming from a scintillator and convert them into an electrical signal. The direct conversion of ionizing radiation into an electrical signal within the same device is a more effective process than indirect conversion, since it improves the signal-to-noise ratio and it reduces the device response time. We report here the use of Organic Semiconducting Single Crystals (OSSCs) as intrinsic direct ionizing radiation detectors, thanks to their stability, good transport properties and large interaction volume. Ionizing radiation X-ray detectors, based on low-cost solution-grown OSSCs, are here shown to operate at room temperature, providing a stable linear response with increasing dose rate in the ambient atmosphere and in high radiation environments.

RP37) S. Cacovich, G. Divitini, E. Capria, A. Fraleoni-Morgera, V. Lughi, C. Ducati, "Nanoscale characterisation of hybrid photovoltaic cells based on C 61 capped CdSe QDs", *J. Phys. Conf. Series*, **2014**, 1, 12071 (IF not available)

Hybrid solar cells based on 1,2 methanofullerene (C61) capped CdSe and poly (3-hexylthiophene) (P3HT) were been investigated through a range of techniques. High resolution transmission electron microscopy (HRTEM) was used to characterize size, morphology and crystal structure of as-grown and C 61-capped CdSe quantum dots. Cross sectional lamellar specimens were prepared from full photovoltaic devices using a focused ion beam milling approach. The sections were analysed by high angle annular dark field imaging in scanning TEM mode to determine the morphology of the device, in particular the intermixing of P3HT and capped quantum dots.

RP38) G. Olivieri, A. Cossaro, E. Capria, L. Benevoli, M. Coreno, M. De Simone, K. C. Prince, G. Kladnik, D. Cvetko, B. Fraboni, A. Morgante, L. Floreano, A. Fraleoni-Morgera*, “Intermolecular Hydrogen Bonding and Molecular Orbital Distortion in 4-Hydroxycyanobenzene Investigated by X-ray Spectroscopy”, *J. Phys. Chem. C*, **2015**, 119, 121-129 (I.F. 2015=4.509)

Electronic structure of 4-hydroxycyanobenzene in the gas phase, thick films, and single crystals has been investigated by X-ray photoemission spectroscopy (XPS) and near edge X-ray absorption fine structure spectroscopy (NEXAFS). We have used resonant photoemission spectroscopy (RESPES) to identify the symmetry and atomic localization of the occupied and unoccupied molecular orbitals for the free molecule. Upon condensation into a thick film, we find XPS energy shifts in opposite directions for the oxygen and nitrogen core levels, consistent with the formation of an intermolecular hydrogen bond. This interaction is also accompanied by a significant spatial distortion of the lowest unoccupied molecular orbital that is displaced from the nitrogen atom, as indicated by the RESPES measurements. Thick films and single crystals display the same dichroism in polarization dependent NEXAFS, indicating that the intermolecular hydrogen bonding also steers the molecular assembly into a preferred molecular orientation.

RP39) G. Palma, L. Cozzarini, E. Capria, A. Fraleoni-Morgera*, “A home-made system for IPCE measurement of standard and dye-sensitized solar cells”, *Rev. Sci. Instrum.*, **2015**, 86, 013112 (IF 2015=1.336)

A home-made system for incident photon-to-electron conversion efficiency (IPCE) characterization, based on a double-beam UV-Vis spectrophotometer, has been set up. In addition to its low cost (compared to the commercially available apparatuses), the double-beam configuration gives the advantage to measure, autonomously and with no need for supplementary equipment, the lamp power in real time, compensating possible variations of the spectral emission intensity and quality, thus reducing measurement times. To manage the optical and electronic components of the system, a custom software has been developed. Validations carried out on a common silicon-based photodiode and on a dye-sensitized solar cell confirm the possibility to adopt this system for determining the IPCE of solar cells, including dye-sensitized ones.

RP40) A. Fraleoni Morgera, V. Lughi, "Frontiers of photovoltaic technology: A Review", *IEEE Xplore*, **2015**, 115-121, DOI: 10.1109/ICCEP.2015.7177610 (IF not available)

As photovoltaics (PV) cost reduction driven by economies of scale is approaching a limit, technological breakthroughs are likely to become again the next driver for further growth. In this paper, we review the most significant photovoltaic (PV) device technologies. First, commercially available cells and modules are briefly surveyed, focusing on the innovations that have recently reached the market, both in silicon-based and thin-film devices. We then identify some significant pre-market technologies such as organic PV and dye-sensitized solar cells, outlining the advantages as well as the obstacles that still hinder large-scale commercialization. A critical review is finally presented for the most promising approaches and some emerging technologies currently under investigation for simultaneously meeting the three key objectives in PV research, all aiming at further reducing the cost per kWh: low fabrication cost, systems integration, and overcoming the standard limit for photoconversion efficiency. All approaches heavily rely on nanotechnology, as the key mechanisms involved in PV conversion occur at the nanoscale.

RP41) L. Basiricò, A. Ciavatti, M. Sibilia, A. Fraleoni-Morgera, S. Trabattoni, A. Sassella, B. Fraboni, "Solid State Organic X-Ray Detectors Based on Rubrene Single Crystals", IEEE Trans. Nucl. Sci., **2015**, 62, 1791-1797 (IF 2015=1.198)

In this work we report the results on the investigation of rubrene single crystals as solid state direct ionizing radiation detectors. With the aim to understand how electrical properties, and in particular a large charge carrier mobility, affect the radiation detection process in organic semiconducting single crystals, we compare the detection performance of rubrene-based devices with those of 1,5-dinitronaphthalene (DNN)-based ones. DNN has been recently proven to be a stable and reliable X-ray direct detector, operating at very low voltages, in air and at room temperature, with a carrier mobility values about two orders of magnitude lower than rubrene. We demonstrate here that the large charge carrier mobility of rubrene crystals does not result in a better X-rays detection performance. In fact, rubrene devices are shown to be less performing than DNN as detectors, with lower sensitivity to X-rays, poorer stability and reproducibility, and longer rise and decay times of the signal.

RP42) A. Ciavatti, E. Capria, A. Fraleoni-Morgera, G. Tromba, D. Dreossi, P. J. Sellin, P. Cosseddu, A. Bonfiglio, B. Fraboni, "Toward Low-Voltage and Bendable X-Ray Direct Detectors Based on Organic Semiconducting Single Crystals", *Adv. Mater.,* **2015**, 27, 7213–7220 (IF 2015=18.32)

Solution-grown organic semiconducting single crystals are robust and easy to handle materials that can reliably detect X-rays in the direct approach, operating at room temperature and in air, providing a linear response to increasing X-ray dose rates. Crystals only a few tens of micrometers thick thus grant a full photogenerated charge collection and this opens the possibility to integrate radiation detectors based on organic crystals into bendable and potentially even flexible electronic devices, exploiting the enhanced fl exibility of thin crystals and the recently reported possibility to cover large areas with inkjet printed single crystalline thin films. Device geometries that maximize the electrode/semiconductor interface active area allow to significantly increase the charge collection efficiency and the X-ray electrical photoresponse of 4HCB single crystals. The reported sensitivity of 4HCB-based detectors is in line with that of state-of-the-art a-Se based detectors.

RP43) E. Viviani, S. Dal Zilio, C. Bertoni, A. Fraleoni-Morgera*, "Nanostructured P3HT layers fabricated by self-assembly as promising gas sensors", *IEEE Xplore*, **2015**, 385-388**,** DOI: 10.1109/PRIME.2015.7251416 (IF not available)

Nanostructured materials for sensors and transducers are of great interest to the scientific community due to several advantages that these materials can provide (e.g., integration with large scale manufacturing technologies, enhanced performances, etc.). Nonetheless, large-area, low-cost and fast processing

technologies for creating effective sensing nanostructures are still sought for. In this work, a recently described technique called Auxiliary Solvent-Based Sublimation-Aided NanoStructuring (ASB-SANS) has been used to generate poly(3-hexylthiophene) (P3HT, a well known semiconducting polymer) nanofilamentary structures onto interdigitated electrodes. These have been tested as gas sensing layers for volatile organic compounds, delivering promising results.

RP44) E. Viviani, C. Bertoni, S. Dal Zilio, A. Fraleoni-Morgera*, "Low-cost and fast wet-based technique to generate nanostructured organic materials layers and its application to chemiresistive gassensing devices", *Procedia Engineer.*, **2015**, 120, 1166–1169 (IF not available)

Poly(3-hexylthiophene) (P3HT) nanofibers fabricated by self-assemby have been used as active sensing layers in chemiresistive gas sensors for acetone, ammonia and water. Their response has been compared to that of analogous devices in which P3HT was present as a plain, non-nanostructured layer. The results of this comparison show that nanofiber-based sensors have faster signal decay times and complete baseline recovery even after being exposed to saturated vapors of the analytes. Moreover, the current response of nanofiber-based devices increases by one order of magnitude or more upon exposure to the analyte, while for plain layers this increase is about 50% at maximum. Finally, on the basis of the collected data, a correlation between the analyte polarizability and the 90% baseline recovery times seems to exist, likely due to the occurrence of just physical adsorption (and not also of vapor penetration) of the analyte onto the polymer surface.

RP45) A. Fraleoni-Morgera*, V. Lughi, "Overview of Small Scale Electric Energy Storage Systems suitable for dedicated coupling with Renewable Micro Sources", *IEEE XPlore*, **2015**, http://dx.doi.org/10.1109/ICRERA.2015.7418653 (IF not available)

Renewable Micro Sources (RENMSs) will strongly contribute to the accelerating electrification trend currently ongoing. Furthermore, the upcoming mass electrification of automotive, with the related pulverized, but numerically important, electricity storage potential, suggests to start considering how to guarantee a stable and sustainable grid power. In this frame, it is interesting to consider the possibility to couple to each RENMS a dedicated Small Scale Electrical Energy Storage System (SS-EESS), so to be able to dispatch out of the RENMS a grid-compliant RENMS-produced power. An overview of SS-EESSs is hence hereby given, under the points of view of their current main technical features and their prospected costs. It is found that mechanical-based systems like Small Scale Compressed Energy Storage and Flywheels are interesting options for RENMS/SS-EESS dedicated coupling, although fast technological progress in the field of SS-EESSs and the emergence of a clear trend towards joining more energy storage principles (like batteries-supercapacitors assemblies) will likely change the landscape of this field in the next years. In this view, further studies over dedicated coupling of SS-EESSs and RENMSs could help to avoid difficulties in dealing with exploding electricity storage problems in the next years.

RP46) B. Fraboni, A. Fraleoni-Morgera, N. Zaitseva, "Ionizing Radiation Detectors Based on Solution-Grown Organic Single Crystals", *Adv. Funct. Mater.*, **2016**, 26, 2276–2291 (Review Paper, IF 2016=12.12)

Organic single crystals (OSCs) have ideal qualities (well defined structure and morphology, lack of grain boundaries, high purity, 3D long range order, good electronic transport properties) for several technological applications, in particular as key components for electronic devices. It is only recently that OSCs have been considered as ionizing radiation detectors, and the latest developments in this field are here reported. In the first section, various methods for OSC growth are described, with emphasis on cost-effective, solution-based approaches capable of delivering large volume, well performing crystals. The second section is focused on the use of solution-grown OSCs as scintillators (i.e., as high energy photon to UV-vis photon conversion), highlighting the ability of cm-scale OSCs to effectively detect neutrons and to carry out neutrons-gamma pulse-shape discrimination tasks. Finally, the third section describes the use of semiconducting, solution-grown OSCs as effective solid state direct detectors (i.e., directly converting high energy photons into charge carriers), evidencing extremely promising performances in terms of operability in environmental conditions (i.e., no need for encapsulation), radiation hardness, linear response and low operating voltage. The latest developments in the application of organic single crystals (OSCs) as ionizing radiation detectors, both as scintillators and as solid state direct detectors, are reviewed. Properties of OSCs relevant to this task are discussed together with the most effective and convenient methods for their growth.

RP47) B. Fraboni, A. Fraleoni-Morgera, Y. Geerts, A. Morpurgo, V. Podzorov, "Organic single crystals: An essential step to new physics and higher performances of optoelectronic devices", *Adv. Funct. Mater.*, **2016**, 26, 2229-2232 (IF 2016=12.12)

The interest in organic single crystals has been further boosted by the development of both solution-growth processes and molecular structures specifically tailored for achieving enhanced solubilities. The synergy

between these features allows for the growth of single crystals of both p- or n-type, in some cases even directly on patterned electrodes. The organic field effect transistor (OFET) occupies a predominant role among the various organic electronic devices that can be realized based on single crystals.

RP48) J. Mohanraj, L. Puzzi, E. Capria, S. Corvaglia, L. Casalis, L. Mestroni, O. Sbaizero, A. Fraleoni-Morgera*, "Easy fabrication of aligned PLLA nanofibers-based 2D scaffolds suitable for cell contact guidance studies", *Mater. Sci. Eng. C.*, **2016**, 62, 301-306 (IF 2016=4.164)

An easy, low-cost and fast wet processing-based method named ASB-SANS (Auxiliary Solvent-Based Sublimation-Aided NanoStructuring) has been used to fabricate poly(l-lactic acid) (PLLA) highly ordered and hierarchically organized 2D fibrillar patterns, with fiber widths between 40 and 500 nm and lengths exceeding tens of microns. A clear contact guidance effect of these nanofibrillar scaffolds with respect to HeLa and NIH-3T3 cells growth has been observed, on top of an overall good viability. For NIH-3T3 pronounced elongation of the cells was observed, as well as a remarkable ability of the patterns to guide the extension of pseudopodia. Moreover, SEM imaging revealed filopodia stemming from both sides of the pseudopodia and aligned with the secondary PLLA nanofibrous structures created by the ASB-SANS procedure. These results validate ASB-SANS as a technique capable to provide biocompatible 2D nanofibrillar patterns suitable for studying phenomena of contact guidance (and, more in general, the behavior of cells onto nanofibrous scaffolds), at very low costs and in an extremely easy way, accessible to virtually any laboratory.

RP49) A. Ciavatti, P. J. Sellin, L. Basiricò, A. Fraleoni-Morgera, B. Fraboni, "Charged-particle spectroscopy in organic semiconducting single crystals", *Appl. Phys. Lett.*, **2016**, 15, 153301 (IF 2016=3.411)

The use of organic materials as radiation detectors has grown, due to the easy processability in liquid phase at room temperature and the possibility to cover large areas by means of low cost deposition techniques. Direct charged-particle detectors based on solution-grown Organic Semiconducting Single Crystals (OSSCs) are shown to be capable to detect charged particles in pulse mode, with very good peak discrimination. The direct charged-particle detection in OSSCs has been assessed both in the planar and in the vertical axes, and a digital pulse processing algorithm has been used to perform pulse height spectroscopy and to study the charge collection efficiency as a function of the applied bias voltage. Taking advantage of the charge spectroscopy and the good peak discrimination of pulse height spectra, an Hecht-like behavior of OSSCs radiation detectors is demonstrated. It has been possible to estimate the mobility-lifetime value in organic materials, a fundamental parameter for the characterization of radiation detectors, whose results are equal to Î¼Ï„coplanar = (5 .5 Â± 0.6) Ã— 10-6 cm2/V and Î¼Ï„sandwich = (1 .9 Â± 0.2) Ã— 10-6 cm2/V, values comparable to those of polycrystalline inorganic detectors. Moreover, alpha particles Time-of-Flight experiments have been carried out to estimate the drift mobility value. The results reported here indicate how charged-particle detectors based on OSSCs possess a great potential as low-cost, large area, solid-state direct detectors operating at room temperature. More interestingly, the good detection efficiency and peak discrimination observed for charged-particle detection in organic materials (hydrogen-rich molecules) are encouraging for their further exploitation in the detection of thermal and high-energy neutrons.

RP50) I. H. Eryilmaz, J. Mohanraj, S. Dal Zilio, A. Fraleoni-Morgera*, "Controlled self-organization of polymer nanopatterns over large areas", *Sci. Rep.*, **2017**, 7, 10526 (IF 2017: 4.122)

Self-assembly methods allow to obtain ordered patterns on surfaces with exquisite precision, but often lack in effectiveness over large areas. Here we report on the realization of hierarchically ordered polymethylmethacrylate (PMMA) nanofibres and nanodots over large areas from solution via a fast, easy and low-cost method named ASB-SANS, based on a ternary solution that is cast on the substrate. Simple changes to the ternary solution composition allow to control the transition from nanofibres to nanodots, via a wide range of intermediate topologies. The ternary solution includes the material to be patterned, a liquid solvent and a solid substance able to sublimate. The analysis of the fibres/dots width and inter-pattern distance variations with respect to the ratio between the solution components suggests that the macromolecular chains mobility in the solidified sublimating substance follows Zimm-like models (mobility of macromolecules in diluted liquid solutions). A qualitative explanation of the self-assembly phenomena originating the observed nanopatterns is given. Finally, ASB-SANS-generated PMMA nanodots arrays have been used as lithographic masks for a silicon substrate and submitted to Inductively Coupled Plasma-Reactive Ion Etching (ICP-RIE). As a result, nanopillars with remarkably high aspect ratios have been achieved over areas as large as several millimeters square, highlighting an interesting potential of ASB-SANS in practical applications like photon trapping in photovoltaic cells, surface-enhanced sensors, plasmonics.

RP51) G. Pipan, M. Bogar, A. Ciavatti, L. Basiricò, T. Cramer, B. Fraboni, A. Fraleoni-Morgera*, "Direct inkjet printing of TIPS-Pentacene single crystals onto interdigitated electrodes by chemical confinement", *Adv. Mater. Interfaces*, **2017**, 1700925 (IF 2017: 4.834)

Organic semiconducting single crystals (OSSCs) are very promising for low-cost electronics, being the highest performers among organic semiconductors in terms of charge transport, with carrier mobilities exceeding 10 cm2 V sâ˜'1. Here, it is demonstrated how it is possible to obtain millimeter-long single crystals of 6,13-bis(triisopropylsilylethynyl)pentacene (TIPS-pentacene) onto gold interdigitated electrodes patterned onto flexible plastic substrates, via direct inkjet printing of precursor solutions. This result is enabled by a novel chemical confinement strategy that exploits fluorinated thiols as solvophobic â€œchemical fencesâ€, able to avoid the printed solution spreading, thus promoting the formation of single crystals even on highly heterogeneous surfaces, without changing the chemical nature of the surface underlying the grown crystals. Electrical measurements demonstrate a good electrical contact with the electrodes. Moreover, their response UV-vis (Ultraviolet-visible) is among the highest up to now reported for organic UVâ€“vis photodetectors, and their performance as direct X-ray detectors is satisfactory, confirming that the printed crystals have an effective electrical contact with the underlying electrodes. Since both the solvophobic fence and the TIPS crystals precursor solution are inkjet printed on flexible substrates, this work opens novel perspectives for the practical use of OSSCs in low cost, yet performing, flexible electronics.

RP52) J. Mohanraj, E. Capria, L. Benevoli, A. Perucchi, N. Demitri, A. Fraleoni-Morgera*, "XRD- and infrared-probed anisotropic thermal expansion properties of an organic semiconducting single crystal", *Phys. Chem. Chem. Phys.*, **2018**, 20, 1984-1992 (IF 2017: 3.906)

The anisotropic thermal expansion properties of an organic semiconducting single crystal constituted by 4-hydroxycyanobenzene (4HCB) have been probed by XRD in the range 120-300 K. The anisotropic thermal expansion coefficients for the three crystallographic axes and for the crystal volume have been determined. A careful analysis of the crystal structure revealed that the two different H-bonds stemming from the two independent, differently oriented 4HCB molecules composing the unit cell have different rearrangement patterns upon temperature variations, in terms of both bond length and bond angle. Linearly Polarized Mid InfraRed (LP-MIR) measurements carried out in the same temperature range, focused on the O-H bond spectral region, confirm this finding. The same LP-MIR measurements, on the basis of a semi-empirical relation and of geometrical considerations and assumptions, allowed calculation of the-CNâ‹¯H-O-hydrogen bond length along the a and b axes of the crystal. In turn, the so-calculated-CNâ‹¯H-O-bond lengths were used to derive the thermal expansion coefficients along the corresponding crystal axes, as well as the volumetric one, using just the LP-MIR data. Reasonable to good agreement with the same values obtained from XRD measurements was obtained. This proof-of-principle opens interesting perspectives about the possible development of a rapid, low cost and industry-friendly assessment of the thermal expansion properties of organic semiconducting single crystals (OSSCs) involving hydrogen bonds.

RP53) I. Cesini, P. Kumar, A. Fraleoni Morgera, C. M. Oddo, "ZnO nanorod array-based tactile transducers for biomedical applications", *Proceedings of GNB2018*, **2018** (IF not available)

ZnO nanorods (NRs) are well known for their excellent piezoelectric and semiconducting properties, and their large energy bandgap (3.37 eV). Furthermore, ZnO is biocompatible, biodegradable and biosafe, which make it suitable for biomedical applications, such as biosensors, and soft tactile sensors to mimic human skin. For many of these applications it is required to synthesize high density and well-aligned ZnO NRs, possibly vertically aligned with respect to the substrate. In this work ZnO NRs growth was carried out with low temperature hydrothermal method on rigid substrates, with no use of seed layers, electrochemistry or lithography. Our study shows that hydrothermal method can be optimized to obtain vertically aligned ZnO NRs with different aspect ratios, by tuning the growth temperature and controlling the substrate roughness. Based on these findings, we developed a first prototype of ZnO NRs-based tactile transducer. The low temperature hydrothermal method holds promise for the fabrication of ZnO NRs array-based tactile sensors with a low-cost process.

RP54) E. Di Bernardo, A. Fraleoni-Morgera*, A. Iannello, L. Toneatti, D. Pozzetto, "Economical analysis of alternative uses of biogas produced by an anaerobic digestion plant", Int. J. Environ. Res., **2019**, 13, 199 (IF 2019: 2.007)

In the frame of the Italian market and regulations, some alternative uses of biogas produced by an anaerobic digestion plant fuelled by zootechnical effluents, integrated with corn silage, are investigated. In particular, on the basis of an existing plant, the following alternatives to the use of the generated biogas are analyzed and compared under the economical point of view:
use of a cogeneration plant to produce electric energy (self-consumption and sale of the surplus to the power supply network operator) and thermal energy (digester and post-digester heating, and feeding of a cereal dryer);

use of a trigeneration plant to produce electric energy (self-consumption and sale of the surplus to the power supply network operator) and thermal/refrigeration energy (heating of the digester and post-digester, and air conditioning of the company's warehouses);
use of a regenerative water-based scrubbing plant for up-grading the quality of the produced biogas, obtaining biomethane for direct sale to the network operator.
This comparison is carried out considering the technical differences between the three alternatives, as well as the related investment and operative costs. A sensitivity analysis on the main parameters influencing the payback time of the three alternatives has been also carried out, showing that the most important parameter to consider is the cost of energy (as either electric or biomethane vector). On these grounds, using the Net Present Value approach, an assessment of the most convenient option in terms of shortest payback time and highest returns is made.

RP55) A. Fraleoni-Morgera*, M. Chhikara, "Polymer-based nano-composites for thermal insulation", Adv. Eng. Mater., **2019**, 1801162 (IF 2019: 3.217)

The growing need for efficient energy use prompts for effective thermally insulating materials. Nano-composites represent an important class of materials able to fulfill these needs, enabling both sizeable energy savings and specific applications where thermal insulation has to be coupled to mechanical robustness and lightness, like in automotive and aerospace.
In view of these developments, this review summarizes the topic of polymer-based nanocomposites for thermal insulation. The theme is introduced overviewing the features of the matrix-filler interfaces and of the available models of thermal conductivity, with a mention of the most used types of polymeric matrices. The main three different types of polymer-based nanocomposites for thermal insulation, i.e. polymeric nano-foams, syntactic foams and all-solid nanocomposites, are then reviewed. For each class of material the thermal insulation performance of selected examples is highlighted, with explicit reference to the material's structure and constitutional peculiarities (like type or size of the filler, specific filler surface functionalizations, etc). A resuming table reporting the thermal insulation performance of selected composites is also included in the review. Finally, an outlook on the possible developments in the field is given.

RP56) C. Bertoni, P. Naclerio, E. Viviani, S. Dal Zilio, S. Carrato, A. Fraleoni-Morgera*, "Nanostructured P3HT as a Promising Sensing Element for Real-Time, Dynamic Detection of Gaseous Acetone", Sensors, **2019**, 19, 1296 (IF 2019: 3.275)

The dynamic response of gas sensors based on poly(3-hexylthiophene) (P3HT) nanofibers (NFs) to gaseous acetone was assessed using a setup based on flow-injection analysis, aimed at emulating actual breath exhalation. The setup was validated by using a commercially available sensor. The P3HT NFs sensors tested in dynamic flow conditions showed satisfactory reproducibility down to about 3.5 ppm acetone concentration, a linear response over a clinically relevant concentration range (3.5-35 ppm), excellent baseline recovery and reversibility upon repeated exposures to the analyte, short pulse rise and fall times (less than 1 s and about 2 s, respectively) and low power consumption (few nW), with no relevant response to water. Comparable responses' decay times under either nitrogen or dry air suggest that the mechanisms at work is mainly attributable to specific analyte-semiconducting polymer interactions. These results open the way to the use of P3HT NFs-based sensing elements for the realization of portable, real-time electronic noses for on-the-fly exhaled breath analysis.

RP57) D. Gentili, I. Manet, F. Liscio, M. Barbalinardo, S. Milita, C. Bettini, L. Favaretto, M. Melucci, A. Fraleoni-Morgera, M. Cavallini, "Control of polymorphism in thiophene derivatives by sublimation-aided nanostructuring", Chem. Commun., **2020**, 56, 1689-1692 (IF 2019: 5.996)

Here we applied a novel concept of ''sublimation-aided nanostructuring'' to control the polymorphism of a model material. The process exploits fractional precipitation as a tool for crystallisation in confinement using a templating agent that sublimes away from the system at the end of the process.

RP58) A. Fraleoni-Morgera,* I. Cesini, P. Kumar, C. M. Oddo, "Hydrothermally Grown ZnO Nanorods as Promising Materials for Low Cost Electronic Skin", ChemNanoMat, **2020**, 6, 15-31 (IF 2019: 3.384)

ZnO nanorods (NRs) are nanomaterials with a wide range of applications (photocatalysis, optoelectronics, catalysis, etc). One peculiar property of ZnO NRs is their piezoelectricity, which opens up a wealth of possibilities in the field of pressure sensors. In fact, thanks also to the recent availability of low cost hydrothermal growth, it is already possible to fabricate flexible, large area, self-powered, distributed pressure sensors, with a high potential for use in robotics and prosthetics as "electronic skins". This review focuses hence on ZnO NRs grown by the hydrothermal method, with an eye on the relationship between the reaction parameters and the resulting NRs morphology, and on their specific application in pressure sensing in terms of device design and performance.

RP59) L. Di Silvio, E. Lunedei, D. Gentili, M. Barbalinardo, I. Manet, S. Milita, F. Liscio, A. Fraleoni-Morgera*, M. Cavallini, "Combined wet lithography and fractional precipitation as a tool for fabrication of spatially controlled nanostructures of poly(3-hexylthiophene) ordered aggregates", Nanoscale, **2020**,12, 1432-1437 (IF 2019: 6.895)

Herein, we propose an easy and practical method for the fabrication of highly ordered supramolecular structures. The proposed approach combines fractional precipitation and wet lithography, to obtain a spatially-defined pattern of submicrometric structures with a high molecular order of poly(3-hexylthiophene). The process is demonstrated by XRD, confocal and time-resolved spectroscopy and by the performance of an effective field effect transistor.

RP60) I. Cesini, M. Kowalczyk, A. Lucantonio, G. D'Alesio, P. Kumar, D. Camboni, L. Massari, P. Pingue, "Seedless Hydrothermal Growth of ZnO Nanorods as a Promising Route for Flexible Tactile Sensors", Nanomaterials **2020**, 10, 977 (IF 2019: 4.324)

Hydrothermal growth of ZnO nanorods has been widely used for the development of tactile sensors, with the aid of ZnO seed layers, favoring the growth of dense and vertically aligned nanorods. However, seed layers represent an additional fabrication step in the sensor design. In this study, a seedless hydrothermal growth of ZnO nanorods was carried out on Au-coated Si and polyimide substrates. The effects of both the Au morphology and the growth temperature on the characteristics of the nanorods were investigated, finding that smaller Au grains produced tilted rods, while larger grains provided vertical rods. Highly dense and high-aspect-ratio nanorods with hexagonal prismatic shape were obtained at 75 and 85 C, while pyramid-like rods were grown when the temperature was set to 95 C. Finite-element simulations demonstrated that prismatic rods produce higher voltage responses than the pyramid-shaped ones. A tactile sensor, with an active area of 1 cm2, was fabricated on flexible polyimide substrate and embedding the nanorods forest in a polydimethylsiloxane matrix as a separation layer between the bottom and the top Au electrodes. The prototype showed clear responses upon applied loads of 2–4 N and vibrations over frequencies in the range of 20–800 Hz.

RP61) L. Toneatti, C. Deluca, A. Fraleoni-Morgera, D. Pozzetto, "Rationalization and optimization of waste management and treatment in modern cruise ships", Waste Manag. **2020**, 118, 209–218 (IF 2019: 5.448)

Here we report over possible optimizations onboard cruise ships in the management of glass, paper and cellulosic waste, ranging from simple rationalization of the materials' use (for glass and paper) to the recovery of some of the energy embedded in paper and other cellulosic waste. This latter option is investigated considering two possibilities: i) the recovery of thermal energy from incinerator's flue gas by means of an absorption plant, ii) the production of syngas to be directly fed to the ship engines. For each option, we calculated the achievable benefits in terms of reduced fuel consumption, avoided CO2 emissions and cost savings (evaluated on the basis of the avoided fuel consumption). Finally, on the basis of the previously calculated benefits, we defined three different scenarios, each including the rationalization of glass and paper waste management, topped by different combinations of thermal energy recovery/syngas production. We then evaluated these scenarios in terms of environmental and economic benefits. This analysis showed that even trivial approaches, as a simple rationalization of paper consumption, can allow consistent advantages over existing waste management policies; moreover, syngas generators for treating cellulosic waste emerged as very effective tools for lowering the environmental impact of modern cruise ships. Joining these two strategies allows notable savings in terms of fuel, CO2 emissions and ship operational costs, and could represent a path for sizably reducing the environmental footprint of cruise ships.

RP62) E. Betz-Güttner, M. Righi, S. Micera, A. Fraleoni-Morgera*, "Directional Growth of cm-Long PLGA Nanofibers by a Simple and Fast Wet-Processing Method", Materials **2022**, 15, 687

The development of aligned nanofibers as useful scaffolds for tissue engineering is an actively sought-for research objective. Here, we propose a novel improvement of an existing self-assembly-based nanofabrication technique (ASB-SANS). This improvement, which we termed Directional ASB-SANS, allows one to produce cm^2-large domains of highly aligned poly(lactic-co-glycolic acid) (PLGA) nanofibers in a rapid, inexpensive, and easy way. The so-grown aligned PLGA nanofibers exhibited remarkable adhesion to different substrates (glass, polyimide, and Si/SiOx), even when immersed in PBS solution and kept at physiological temperature (37 °C) for up to two weeks. Finally, the Directional ASB-SANS technique allowed us to grow PLGA fibers also on highly heterogeneous substrates such as polyimide-based, gold-coated flexible electrodes. These results suggest the viability of Directional ASB-SANS method for realizing biocompatible/bioresorbable, nanostructured coatings, potentially suitable for neural interface systems.

RP63) L. Toneatti, C. Deluca, A. Fraleoni Morgera, M. Piller, D. Pozzetto, "Waste to Energy Onboard Cruise Ships: A New Paradigm for Sustainable Cruising", J. Marine Sci. Eng., **2022**, 10,480

The newest cruise ships can guest a constantly increasing number of passengers and concentrate their environmental impact on the limited areas interested by their path. The generated solid waste contributes significantly to this impact; therefore, we propose an innovative solution for recovering embedded energy from that garbage. In more detail, we study the feasibility of an absorption plant able to exploit the residual energy of the flue gas of the ship's incinerator. No payload space shall be sacrificed to install the considered absorption plant. Furthermore, it can be integrated with the existing plants providing for a limited number of heat exchangers. The recovered energy can be used to control the temperature of the refrigerated storerooms; operating simultaneously with, or in place of the existing compression vapors system already installed; it allows a reduction of the CO2 emissions and of fuel consumption. We show that the proposed approach can be applied to a variety of cruise ships, independently of their tonnage or passenger capacity.

RP64) R. Svigelj, R. Toniolo, C. Bertoni, A. Fraleoni-Morgera*, "Synergistic Applications of Graphene-Based Materials and Deep Eutectic Solvents in Sustainable Sensing: A Comprehensive Review", Sensors**, 2024**, 24, 2403

The recently explored synergistic combination of graphene-based materials and deep eutectic solvents (DESs) is opening novel and effective avenues for developing sensing devices with optimized features. In more detail, remarkable potential in terms of simplicity, sustainability, and cost-effectiveness of this combination have been demonstrated for sensors, resulting in the creation of hybrid devices with enhanced signal-to-noise ratios, linearities, and selectivity. Therefore, this review aims to provide a comprehensive overview of the currently available scientific literature discussing investigations and applications of sensors that integrate graphene-based materials and deep eutectic solvents, with an outlook for the most promising developments of this approach.

RP65) A. Fraleoni-Morgera*, M. Afshani, S. Montelpare, C. Lops, "Sustainable Micro- and Nanocomposites for Thermal Insulation in Buildings", Advanced Engineering Materials, **2024**, 26,2301064

Energy efficiency in buildings requires adequate materials for thermal insulation. Given the enormous number of buildings worldwide needing a retrofit to improve their energy efficiency, it is of capital importance to identify materials suitable for sustainable thermal insulation. Among the many available insulators, polyurethanes occupy a preeminent role, given their versatility and effectiveness, and are thus expected to be extensively used in retrofitting buildings for improving their energy efficiency. Herein, the currently available bio-derived or recyclable polyurethane-based composites, considering them as either foams (i.e., with gaseous filler) or fully solid (i.e., with solid filler) composites, are assessed. The first section of the review is devoted to bioderived PUs as matrices for thermally insulating composites; the second section focuses on bio-derived/recyclable fillers adopted with PUs as matrices, with specific reference to silica-based aerogels. The main issues of the surveyed bio-based composites are analyzed, and the future prospects of these materials, that are actually sustainable but at the same time performance effective, are discussed.

BC - Book chapters

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OP – Other papers

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OC - Oral Contributions at conferences

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Ai sensi degli artt. 45 e 46 del DPR 28 dicembre 2000 n. 445, e consapevole che le dichiarazioni mendaci sono punite ai sensi del codice penale e delle leggi speciali in materia, secondo le disposizioni richiamate nel DPR 28 dicembre 2000 n. 445, dichiaro che quanto sopra riportato corrisponde al vero.

In fede,

Alessandro Fraleoni Morgera