DOCENTE

Nome:	**Daniele**
Cognome:	**Franchi**
Ruolo attuale:	**Ricercatore**
SSD:	**CHIM/06 - Chimica organica**
Afferenza:	**CNR-ICCOM** *National Research Council of Italy – Institute of Chemistry of Organometallic Compounds.*
	CNR-ICCOM *Consiglio Nazionale delle Ricerche – Istituto di Chimica dei Composti Organometallici.*
Recapiti:	**+39 055 5225223**
	daniele.franchi@cnr.it
Web site:	**https://www.cnr.it/en/people/daniele.franchi**

Biografia

Il Dr. Franchi ha conseguito la Laurea Specialistica in Chimica (curriculum organico) nel 2013 presso l'Università degli Studi di Firenze sotto la tutela di Pr. Goti e Dr. Mordini, sintetizzando su una serie di fotosensibilizzatori organici per sistemi fotovoltaici. In seguito, grazie al conferimento di una borsa di studio da parte della Fondazione Blanceflor Boncompagni Ludovisi, neé Bildt, tra il 2014 ed il 2015 ha trascorso un periodo di un anno come visiting Ph.D. presso la Chalmers University of Technology di Göteborg (Svezia) collaborando con Pr. Abrahamsson su metodi di caratterizzazione di interfasi tramite spettroscopia transiente; ha quindi conseguito il Dottorato di Ricerca Europeo (Doctor Europaeus) in Scienze Chimiche presso l'Università degli Studi di Firenze nel 2017 sempre sotto la tutela del Dr. Mordini. Dopo un primo post-doc presso il CNR-ICCOM di Firenze, dal 2018 al 2020 è stato impiegato post-doc presso il Politecnico (KTH) di Stoccolma (Svezia) nel gruppo di ricerca del Pr. Sun dove ha svolto ricerche su coloranti a base di complessi eterolettici di rame e polimeri conduttori di lacune, acquisendo dimestichezza con metodi di indagine elettrochimici. Da Settembre 2020 il Dr. Franchi ha ottenuto il ruolo di Ricercatore presso il CNR-ICCOM nell'ambito della Green Chemistry, e svolge ricerca su tecnologie fotovoltaiche emergenti e fotocatalisi eterogenea.

Dr. Franchi received his Master's Degree in Chemistry (curriculum: organic chemistry) in 2013 at the University of Florence under the supervision of Pr. Goti and Dr. Mordini, synthesizing a series of organic photosensitizers for photovoltaic applications. Later, thanks to the allocation of a scholarship by the Blanceflor Boncompagni Ludovisi Foundation, neé Bildt, between 2014 and 2015 he spent one year as Visiting Ph.D. student at the Chalmers University of Technology in Gothenburg (Sweden) collaborating with Pr. Abrahamsson on interphases characterization methods by transient spectroscopy; he obtained the European Research Doctorate (Doctor Europaeus) in Chemical Sciences at the University of Florence in 2017 under the supervision of Dr. Mordini. After a first post-doc at the CNR-ICCOM in Florence, from 2018 to 2020 he was employed as post-doc at the Royal Institute of Technology (KTH) of Stockholm (Sweden) in the research group of the Pr. Sun where he carried out research on copper heteroleptic complexes and hole conducting polymers, gaining expertise in electrochemical investigation methods. Since September 2020, Dr. Franchi has obtained the role of Researcher at CNR-ICCOM in the field of Green Chemistry: his major research interests are emerging photovoltaic technologies and heterogeneous photocatalysis.

Curriculum

EMPLOYMENT HISTORY:

Since 30/09/2020
Researcher at CNR-ICCOM
National Research Council of Italy - Institute of Chemistry of OrganoMetallic Compounds, Firenze, Italy.
Field of Green Chemistry: Photovoltaic, Photocatalysis.

17/09/2018 – 16/09/2020
Postdoctoral researcher at KTH
Royal Institute of Technology, Stockholm, Sweden.
Organic dyes, Copper complexes, and hole conductive polymers for Photovoltaic. Supervisor: Pr. L. Sun.

15/03/2017 – 31/08/2018
Postdoctoral researcher at CNR-ICCOM
National Research Council of Italy - Institute of Chemistry of OrganoMetallic Compounds, Firenze, Italy.
Organic Synthesis and Photovoltaic technology development. Supervisor: Dr. A. Mordini.

EDUCATION:

01/11/2013 – 28/02/2017
Ph.D. in Organic Chemistry - "Università degli studi di Firenze", Firenze, Italy. (Doctor Europaeus)
Thesis: Optimization of components for Dye-Sensitized Solar Cells: a combined approach for performance improvement. Supervisor: Dr. A. Mordini

01/08/2014 – 31/07/2015
Visiting Ph.D. student - "CHALMERS" Göteborg, Sweden.
Project: Development of long lifetime DSSC devices. Granted by: The Foundation Blanceflor.

01/10/2009 – 22/04/2013
Master of Science in Chemistry - "Università degli studi di Firenze", Firenze, Italy.
Curriculum: synthesis, structure, and property of organic compounds.
Thesis: Synthesis and characterization of new D-π-A organic photosensitizers for DSSC with pyridine-moiety acceptor. Supervisor: Pr. A. Goti

01/10/2006 – 14/12/2009
Bachelor of Science in Chemistry - "Università degli studi di Firenze", Firenze, Italy.
Thesis: Synthesis and determination of enantiomeric excess of FmocArg(Boc)$_2$-H. Supervisor: Pr. A. M. Papini

01/02/2009 – 31/07/2009
Erasmus trainee - VUB Vrije Universiteit Brussel, Bruxelles, Belgium.
Synthesis and determination of enantiomeric excess of FmocArg(Boc)$_2$-H. Supervisor: Pr. D. Tourwe

TEACHING, TUTORING, AND OUTREACH

01/06/2021 – 20/09/2021
Lecturer: Unconventional reaction activation techniques in Organic Synthesis. (8 hours)
Ph.D. school of "Università degli studi di Firenze", Firenze, Italy.
Ph.D. school of "Università degli studi di Siena", Siena, Italy.

Since 01/05/2021
Students' thesis supervisor
on behalf of "Università degli studi di Firenze", Firenze, Italy
and "Università degli studi di Siena", Siena, Italy.

01/03/2018 – 31/08/2018
150 seconds contest winner - Science divulgation. Financed by ChemPubSocEurope. Austria.
Premio GiovedìScienza contest 2nd ranched - Science divulgation. Financed by GiovedìScienza. Italy.
ScienceMe contest winner - Science divulgation. Promoted by University of Geneva. Switzerland.

01/01/2016 – 31/08/2018
Supervisor of French and Italian undergraduates' internships
on behalf of CNR-ICCOM, Institute of Chemistry of OrganoMetallic Compounds, Firenze, Italy.

09/04/2013 – 12/06/2014
High school teacher of practical classes in Chemistry. (320 hours/year)
"T. Buzzi" Public high school, Prato, Italy.

SCIENTIFIC CONTRIBUTIONS AT CONFERENCES

Hydrophobic Hole-Conductive Polymers for Perovskite Solar Cell Application
ISOC 2019 - 12th International School of Organometallic Chemistry - 2019 Italy - [Oral Communication]

Structural modification of diimine ligands:customize optical and electrochemical properties of Cu complexes
CDCO-SCI 2019 - 29th Conference of the division of Organic Chemistry of the Italian Society of Chemistry - 2019 Italy - [Poster]

DSSC: a synthetic approach for FRET increasing LHE dyes
ICOMC 2018 - 28th International Conference on Organometallic Chemistry - 2018 Italy - [Poster]

Green organic dyes for DSSC application based on D-A-π-A design bearing Indigo structure
Dyenamo DSSC conference - 2017 Sweden - [Poster]

Versatile insertion of acceptors moiety in organic photosensitizers to improve stability in DSSCs working conditions
ISOS 2016 - International Summer School in Organic Synthesis - 2016 Italy - [Oral Communication]
IASOC 2016 - Ischia Advanced School in Organic Chemistry - 2016 Italy - [Poster]

Synthesis and application of new, pyridine-containing D-π-A organic photosensitizers for DSSCs
SAYCS15 - Sigma Aldrich Yung Chemist Symposium - 2015 Italy - [Oral Communication]
EnerCHEM 1 - 1st conference of the Interdisciplinary Group of Chemistry for Renewable Energy of the Italian Chemistry Society - 2016 Italy - [Poster]

Plasmonic TiO2 thin films: interaction between Au nanoparticles and organic dyes for DSSC applications
HOPV15 - International Conference on Hybrid and Organic PhotoVoltaics - 2015 Italy - [Poster]

Synthesis and characterization of new D-π-A organic photosensitizers for DSSC
Co.G.I.C.O. 2014 - 11th Conference of the Interdisciplinary Group of Organometallic Compounds of the Italian Chemistry Society - 2014 Italy - [Short Communication]
SISOC X - 10th Spanish Italian Symposium of Organic Chemistry - 2014 Italy - [Poster]

Interessi
L'interesse principale del Dr. Franchi è lo sviluppo di materiali organici per la funzionalizzazione dei semiconduttori, da applicare in tecnologie sostenibili atte alla produzione di energia fotovoltaica, la sintesi catalitica di combustibili solari e la fotocatalisi in sintesi organica.
Il tema della sintesi organica mediata da cross-coupling è sempre presente nei suoi lavori scientifici, ne fa uso per sintetizzare coloranti organici largamente coniugati e materiali polimerici conduttori di lacune. Coglie spesso l'occasione di sfruttare procedure di sintesi non convenzionali tra cui l'attivazione con microonde o ultrasuoni e la sintesi in fase solida di complessi eterolettici. È coinvolto nelle lavorazioni, funzionalizzazioni e caratterizzazioni di strati sottili di semiconduttori. È appassionato di metodi analitici come l'NMR eteronucleare bidimensionale, la spettroscopia di assorbimento su campioni solidi e la voltammetria ciclica applicata all'elettrosintesi.
Di recente ha iniziato a studiare e sviluppare nuovi ligandi per semiconduttori per creare fotocatalizzatori eterogenei sensibili alla luce visibile.

Dr. Franchi's main interest is the development of organic materials for semiconductors functionalization, to be applied in sustainable technologies, namely: photovoltaic energy production, solar-fuels catalytic synthesis, and photocatalytic organic transformations.
The topic of cross-coupling mediated organic synthesis is ever-present in his scientific works, he uses so to synthesize large conjugated organic dyes and polymeric hole conducting materials. He is curious about exploiting uncommon procedures including microwaves, ultrasounds, solid-phase synthesis of heteroleptic complexes, and all the processing of semiconductors thin layers. He enjoys analytical methods such as bidimensional and heteronuclear NMR, absorption spectroscopy of solid samples, and cyclic voltammetry for electrosynthesis.
He recently started investigating and developing new ligands for semiconductors to establish sustainable heterogeneous visible-light sensitized photocatalysts.

Pubblicazioni Scopus: 56196741800
WoS: K-8487-2018
OrcID: 0000-0003-2811-247X

D. Franchi, V. Leandri, A. R. P. Pizzichetti, B. Xu, Y. Hao, W. Zhang, T. Sloboda, S. Svanström, U. B. Cappel, L. Kloo, L. Sun, and J. M. Gardner (2022). Effect of the Ancillary Ligand on the Performance of Heteroleptic Cu(I) Diimine Complexes as Dyes in Dye-Sensitized Solar Cells. ACS Applied Energy Materials 5, 1460-1470. ISSN:2574-0962
https://doi.org/10.1021/acsaem.1c02778

G. Goti, M. Calamante, C. Coppola, A. Dessì, D. Franchi, A. Mordini, A. Sinicropi, L. Zani, G. Reginato (2021). Donor-Acceptor-Donor Thienopyrazine-Based Dyes as NIR-Emitting AIEgens. *European Journal of Organic Chemistry*, 18, 2655-2664. ISSN:1099-0690
https://doi.org/10.1002/ejoc.202100199

X. Yzeiri, M. Calamante, A. Dessì, D. Franchi, A. Pucci, F. Ventura, G. Reginato, L. Zani, A. Mordini (2021). Synthesis and Spectroscopic Characterization of Thienopyrazine-Based Fluorophores for Application in Luminescent Solar Concentrators (LSCs). Molecules, 26, 5428. ISSN:1420-3049
https://doi.org/10.3390/MOLECULES26185428

D. Franchi* and Z. Amara (2020). Applications of Sensitized-Semiconductors as Heterogeneous Visible-Light Photocatalysts in Organic Synthesis. ACS Sustainable Chemistry & Engineering, 8, 15405–15429. ISSN:2168-0485
https://doi.org/10.1021/acssuschemeng.0c05179

D. Franchi, M. Calamante, C. Coppola, A. Mordini, G. Reginato, A. Sinicropi, L. Zani (2020). Synthesis and characterization of new organic dyes containing the indigo core. Molecules, 25, 3377. ISSN:1420-3049
https://doi.org/10.3390/molecules25153377

V. Leandri, A. R. Pia Pizzichetti, B. Xu, D. Franchi, W. Zhang, I. Benesperi, M. Freitag, L. Sun, L. Kloo, J. M. Gardner (2019). Exploring the Optical and Electrochemical Properties of Homoleptic versus Heteroleptic Diimine Copper(I) Complexes. Inorganic Chemistry, 58, 12167-12177. ISSN:1520-510X
https://doi.org/10.1021/acs.inorgchem.9b01487

Z. Yao, Y. Guo, L. Wang, Y. Hao, Y. Guo, D. Franchi, F. Zhang, L. Kloo, L. Sun (2019). Energy-Loss Reduction as a Strategy to Improve the Efficiency of Dye-Sensitized Solar Cells. Solar RRL, 3, 1900253. ISSN:2367-198X
https://doi.org/10.1002/solr.201900253

L. Zani, A. Dessì, D. Franchi, M. Calamante, G. Reginato, A. Mordini (2019). Transition metal-catalyzed cross-coupling methodologies for the engineering of small molecules with applications in organic electronics and photovoltaics. Coordination Chemistry Reviews, 392, 177-236. ISSN:108545
https://doi.org/10.1016/j.ccr.2019.04.007

M. Steiner, B. Brandi, D. Franchi, F. Tavanti, J. Dutzler, D. Hochfilzer, D. Menia (2019). Presenting Your Research Concisely to a Broad Audience. ChemViews. ISSN:2190-3735
https://doi.org/10.1002/chemv.201900037

A. Dessì, A. Sinicropi, S. Mohammadpourasl, R. Basosi, M. Taddei, F. Fabrizi de Biani, M. Calamante, L. Zani, A. Mordini, P. Bracq, D. Franchi, G. Reginato (2019). New Blue Donor–Acceptor Pechmann Dyes: Synthesis, Spectroscopic, Electrochemical, and Computational Studies. ACS Omega, 4, 7614-7627. ISSN:2470-1343
https://doi.org/10.1021/acsomega.8b03560

O. Bettucci, D. Franchi, A. Sinicropi, M. di Donato, P. Foggi, F. Fabrizi de Biani, G. Reginato, L. Zani, M. Calamante, A. Mordini (2019). Tailoring the optical properties of organic D-π-A photosensitizers: Effect of sulfur introduction in the acceptor group. European Journal of Organic Chemistry, 4, 812-825. ISSN:1099-0690
https://doi.org/10.1002/ejoc.201801497

C. Papucci, T. A. Geervliet, D. Franchi, O. Bettucci, A. Mordini, G. Reginato, F. Picchioni, A. Pucci, M. Calamante, L. Zani (2018). Green/Yellow-emitting Conjugated Heterocyclic Fluorophores for Luminescent Solar Concentrators. European Journal of Organic Chemistry, 2657–2666. ISSN:1099-0690 https://doi.org/10.1002/ejoc.201800242

G. Reginato, A. Mordini, L. Zani, M. Calamante, D. Franchi (2018). Design and Synthesis of Organic Sensitizers with Enhanced Anchoring Stability in Dye-Sensitized Solar Cells. Pure and Applied Chemistry, 90, 363-376. ISSN:1365-3075 https://doi.org/10.1515/pac-2017-0403

G. Reginato, A. Mordini, L. Zani, M. Calamante, A. Dessì, D. Franchi (2017). The Stille Reaction: Applications in the Synthesis of Organic Dyes for DSSCs. CHIMIA, 71, 586–591. ISSN:0009-4293 https://doi.org/10.2533/chimia.2017.586

V. Saavedra Becerril, D. Franchi, M. Abrahamsson (2016). Ionic Liquid-Induced Local Charge Compensation: Effects on Back Electron-Transfer Rates in Dye-Sensitized TiO2 Thin Films. The Journal of Physical Chemistry C, 120, 20016–20023. ISSN 1932-7447 https://doi.org/10.1021/acs.jpcc.6b06088

D. Franchi, M. Calamante, G. Reginato, L. Zani, M. Peruzzini, M. Taddei, R. Basosi, A. Sinicropi, D. Colonna, A. Di Carlo, A. Mordini (2015). Two New Dyes with Carboxypyridinium Regioisomers as Anchoring Groups for Dye-Sensitized Solar Cells. Synlett, 26, 2389–2394. ISSN : 0936-5214 https://doi.org/10.1055/s-0035-1560713

D. Franchi, M. Calamante, G. Reginato, L. Zani, M. Peruzzini, M. Taddei, F. Fabrizi de Biani, R. Basosi, A. Sinicropi, D. Colonna, A. Di Carlod, A. Mordini (2014). A Comparison of Carboxypyridine Isomers as Sensitizers for Dye-Sensitized Solar Cells: Assessment of Device Efficiency and Stability. Tetrahedron, 70, 6285-6295. ISSN: 0040-4020 https://doi.org/10.1016/j.tet.2014.05.076

TITOLO DEL CORSO
Lights on green chemistry

Lingua insegnamento
English

Contenuto del corso (abstract)
If light was a chemical, there won't be competition for the most sustainable reactant: its cost, cleanness, and availability make it the perfect ingredient for every process. Once the technologies to exploit it were proven, it has started growing in the field of green chemistry rooting in many applications.
Focusing on the green chemistry requirements for energy efficiency, circular economy of materials, and catalytic transformations, in this course we will explore technologies that answer such requirements making use of light's energy like photovoltaics, artificial photosynthesis, and photocatalysis. Once analyzed the technologies working principles, the devices' architecture, and the parameters to evaluate it, we will focus on the role of organic chemistry behind their key components. In fact, when light exploitation is desired, we may find organic compounds playing their key role as photosensitizers. For each technology, we will list the properties expected from organic sensitizers, explore the working mechanisms from a molecular perspective, and finally focus on the most accounted structure-activity relations reported in the literature over the years. The desired outcome would be to give a general knowledge of the potentialities of the class of organic compounds defined as photosensitizers, and to pave some strategies and directions for the development of new compounds that could play an active role in green chemistry, acting as key components in light exploiting technologies.

Programma del corso
Lesson#1
Introduction to the course. Green Chemistry and sustainable technologies exploiting light.
Energy production: photovoltaic. Classification of photovoltaic technologies.

LSC: working principle, device architecture, parameters to evaluate the devices. Luminophores: the role of, required physical and chemical properties, types of luminophores, common features in structural design of organic luminophores. Literature examples.
Lesson#2
DSSC: working principle, device composition, parameters to evaluate the devices. Photosensitizers: the role of the dye, required physical and chemical properties, classes of dyes. Modular design: common features in structural design, planarity of the dye, anchoring and stability, optical transparency. Literature examples.
Lesson#3
Fuels production: solar fuels.
Artificial photosynthesis: photocatalytic water splitting, working principle, two main device architectures, DSPEC, parameters to evaluate the devices. Catalyst-sensitizers relationship, energy transfer mechanisms, I2M and WNA mechanisms, physical and chemical properties of catalyst and sensitizer, common features in structural design. H_2 production: sacrificial electron donors, dye-sensitized photocatalytic hydrogen production, chelating dyes, hydrophilicity effect. Literature examples.
Lesson#4
Organic synthesis: heterogeneous photocatalysis.
Dye-sensitized semiconductors: mechanisms at play, strategies of sensitization. The need for photocatalysts, excitons and energy transfer, devices and light sources, reaction parameters. Photoredox catalysis on semiconductors, common structures in dyes and LMCT sensitizers, redox potentials, the superoxide anion. Literature examples.

Prerequisiti

Corsi vincolanti: nessuno
Corsi raccomandati: nessuno

Totale: 8h

Periodo: June – September 2022

Metodi Didattici

4 Lezioni registrate e rese disponibili entro Giugno 2022

4 Recorded lectures available from June 2022

Modalità di verifica apprendimento (final evaluation)

Elaborazione di un brevissimo progetto di massimo due pagine riportante massimo tre composti organici dalla struttura innovativa, che potrebbero essere impiegati in almeno una delle tecnologie trattate del corso. Evidenziare quali sarebbero le proprietà previste per i composti elaborati supportando le ipotesi con alcune fonti bibliografiche. Argomentare la scelta delle strutture in relazione alle proprietà e all'applicazione ipotizzata. Illustrare brevemente il proprio progetto con massimo cinque slides durante un seminario online con tutta la classe.

Write a short project of maximum two pages reporting the invention of maximum tree organic compounds with unreported structure, that could be exploited in at least one of the theologies presented in the course. Highlighting what properties are foreseen for the compounds, supporting the ideas with few connected literature examples. Explain how the expected properties will make the compounds suitable for the selected technology. Present the project to the class with maximum five slides during an online meeting.