

Curriculum vitae
Clara Santato, Ph.D.

Permanent Research Scientist at the Italian National Research Council, (CNR)
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EDUCATION

2001: Ph.D. University of Geneva (CH). Dissertation: "Preparation and characterization of nanostructured WO₃ films as photoanodes in solar energy conversion". Advisor: Prof. J. Augustynski.

1995: M.Sc. Degree in Chemistry (*Laurea*). University of Bologna (I). Diploma work: "Modification of electrodic surfaces by films of photosensitive polymers: electro- and photopolymerization of amphiphilic polypyridinic Ru(II) complexes". Advisors: Dr A. Deronzier and Prof. S. Roffia.

CAREER HISTORY

Presently Visiting Scientist at Nano-Femto Lab, INRS-EMT, Université du Québec, (Varenes, CA).

2002-present: Permanent Research Scientist at CNR-ISMN, Bologna (Italy).

2005: Visiting Research Scientist at the Department of Chemistry, University of Purdue (IN, USA).

2001-2002: Permanent Research Scientist at CNR, Institute of Advanced Inorganic Methods, Rome (Italy).

1996-2001: Teacher-Assistant, Department of Inorganic, Analytical and Applied Chemistry, University of Geneva (CH).

1999: Visiting Ph.D. Student, National Renewable Energy Laboratory (CO, USA). Supervisor: J. Turner.

1994: Technical Student: EniChem Company - Research Institute "G. Donegani", Novara (Italy).

1994: M.Sc. Diploma work, "Laboratoire d'Electrochimie Organique et de Photochimie Rédox", CNRS – Université J. Fourier, Grenoble (France). Supervisors: Prof. S. Roffia and Dr A. Deronzier.

RESEARCH ACTIVITY

During my M.Sc. diploma work, I investigated the photosensitization of metallic and semiconducting surfaces by the electro- and photopolymerization of amphiphilic pyrrole-substituted polypyridyl Ru(II) complexes. The aim of the work was the preparation of photoelectrodes for liquid-junction photovoltaic cells. The scientific activity involved three research groups, two at the University of Bologna (directed by Prof. V. Balzani and Prof. S. Roffia) and one, directed by Dr. A. Deronzier, at the Université J. Fourier-CNRS in Grenoble. Results were published in *New J. Chem.*

During the Ph.D., I studied hydrogen production via the photoelectrochemical route i.e. by water photoelectrolysis based on the use of metal oxide semiconducting films employed as photocatalysts. In particular, I worked on WO₃ films prepared by annealing a layer of a metal oxide colloidal solution containing organic additives playing both the role of stabilizers and templates. The excellent performance of the WO₃ electrodes enabled the assembly of a 100% solar energy-powered device to produce H₂ (a so called "tandem cell" device). Here, the WO₃-based photoelectrolyser was coupled to a liquid-junction photovoltaic device ("Gratzel's cell") supplying the voltage required for the photoelectrolyser's operation. A global efficiency of 4% was measured. Results were published in *J. Am. Chem. Soc.* (90 citations), *Adv. Mater.* (20 citations), *J. Phys. Chem. B* (40 citations).

After my PhD, I joined the Italian National Research Council (CNR) as Permanent Research Scientist. At CNR-IMAI in Rome, I worked on Si films grown by Plasma-Enhanced Chemical Vapor Deposition. The process of laser-induced crystallization of the films was investigated *in situ* by micro Raman spectroscopy. I figured out a correlation between the He/SiH₄ ratio employed during the growth of the a-Si films and the domain size of the Si nanocrystals obtained after irradiation. Results were published in *J. Appl. Phys.*.

At CNR-ISMN in Bologna, I investigated growth physics, charge injection, charge transport and light-emission in organic semiconducting films made up of molecules from the acene and thiophene families.

I studied the films as active layers in a new class of organic optoelectronic devices i.e. organic light-emitting field-effect transistors (OLETs). OLETs integrate the transistor function with the light emission. The main topics I worked on are: (i) device physics of the tetracene-LET, by correlating transistor current, light emission and external quantum efficiency of the device; (ii) understanding of how deposition parameters, e.g. the deposition flux, influencing the growth of vacuum-sublimed films, influence charge transport properties in the films; (iii) the demonstration of the first OLET on a flexible dielectric substrate (a 900 nm-thick transparent Mylar foil). This finding is extremely valuable in view of the fabrication of lightweight and flexible organic optoelectronic devices; (iv) the preparation of the first OLET based on a solution-processed active layer made up of small molecules. This work demonstrated a new organic optoelectronic material.

The flexibility of the device substrates and the solution processability of the organic active layers are both required to pave the way towards the all plastic optoelectronics of the future. Results were very recently published in *Appl. Phys. Lett.* (20 citations), *Adv. Mat.* (10 citations), *Adv. Funct. Mat.* (25 citations).

With the aim to increase my expertise in developing hybrid organic/inorganic devices, in 2005 I was Visiting Research Scientist at the University of Purdue. I worked on the controlled growth of metal and metal oxide films grown by electrodeposition. As a function of experimental parameters such as the electrical potential and the composition of the electrolytic solution, I tuned the morphologies of Sn films. In particular I prepared films with a wire-like morphology. The latter is very attractive for photoelectrochemical applications since wires provide an efficient path for the transport of the photoproducted conduction band electrons to the back contact of the photoelectrode.

With the aim to prepare novel organic materials with special electronic properties, we work at the the surface-confined polymerization towards 2D conjugated organic polymers. For the preparation, we will select the electrochemical method. The deposited material will be imaged by Scanning Tunnelling Microscopy.

EXPERIENCE IN TEACHING AND TRAINING OF HIGHLY QUALIFIED PERSONNEL

In 2004, I was Scientific Tutor of three graduate students for the *Advanced Methodologies for the Energy Saving and the Environment* project, founded by the Spinner Consortium/Emilia-Romagna region. The project aimed to evaluate the environmental impact and sustainability of the CNR Bologna Research Area.

During six years (1996-2001) I was Teacher-Assistant at the University of Geneva. I taught Quantitative and Qualitative Analytical Chemistry to undergraduate Pharmacy students. The topics were: redox, acid-base and pH volumetric titrations; Potentiometry; Atomic Absorption Spectrometry; UV/Vis Spectrophotometry; Liquid Chromatography; Qualitative Chemistry to identify anions and cations from mixed powders. I gave introductory lectures to experiments to be carried out under my supervision in the laboratory. The time I spent teaching was about 6 hours per week. I had the occasion to supervise two students during their *Licence* diploma works. In several occasions, I replaced one of the Professors of Analytical Chemistry in my Department to give lectures.

In 1995, I had a part-time position to teach Environmental Chemistry at High School (I.T.I. "O. Belluzzi", Bologna, I).

FELLOWSHIPS AND SCHOLARSHIPS AWARDED

2007: Membership to ICYS-ICMR Summer School on Nanomaterials 2007, Tsukuba, Japan.

2006: Award from the Government of Canada for six months research in "Multifunctional hybrid organic/inorganic devices"

2001: Fellowship from the Swiss National Research Foundation for an one year-postdoctoral activity in the USA. I declined this fellowship since I accepted the position of Permanent Research Scientist at CNR.

1995: Erasmus Scholarship from the Foreign Office of the University of Bologna to carry out the M. Sc. Diploma work in France.

PARTICIPATION IN PROJECTS

2003-2004: Injection Lasing in Organics (ILO), EU-IST-FET program, IST-33057.

2000-2001: Water photolysis and hydrogen and oxygen production by solar energy conversion, Swiss Federal Office of Energy (project n° 36826, contract n° 76643).

2000-1998: Hydrogen Program, Annex 14, sponsored by the International Energy Agency.

SPECIFIC SKILLS

Electrical and Optical measurements in light-emitting devices:

- a) current, electroluminescence, external quantum efficiency in field-effect transistor configuration. The measurements were carried out under vacuum with a probe station fixed inside an integrating sphere equipped with a photomultiplier. I also carried out electrical measurements in N₂ glove box.

Photoelectrochemistry:

- a) photocurrent/voltage measurements;
- b) photon-to-current conversion efficiency/wavelength measurements;
- c) use, calibration and maintenance of solar light simulators.

Spectroscopy

- a) UV/Visible
- b) IR
- c) Raman

Electrochemistry

- a) cyclic voltammetry
- b) electrolysis
- c) potentiostatic and galvanostatic electrodeposition.

Characterization of electrochromic devices

- a) simultaneous acquisition of current/voltage and UV/Vis absorption/voltage.
- b) coloration efficiency.

Fabrication of devices

- a) organic field-effect transistors on Si and plastic substrates.

Microscopy

- a) Scanning Electron Microscopy.
- b) Scanning Tunneling Microscopy

X-rays diffraction from metallic and metal oxide films.

Chemical solution preparative methods

- a) sol-gel chemistry.

Deposition methods from solutions

- a) spin coating

b) drop casting

SEMINARS AND LECTURES

Ecole Polytechnique de Montreal, July, 2006
S3-INFM, Modena Italy, July 2006
Summer School in Organic Multifunctional Materials, Tortoli', Italy, June 2006.
INRS-EMT, Université du Québec à Varennes, Canada, September 2005.
University of Geneva, February 2005.
University of Cagliari, Italy, December 2004.
Yale University, New Heaven, CT, USA, May 2002.
Windsor University, Ontario, Canada, May 2002.
Harvard University, MT, USA, June 2002.
University of California at Berkeley, CA, USA June 2002.
University of California at Santa Barbara, CA, USA, June 2002.
University of São Paulo, Brazil, August 2001.
IMAI-CNR- Rome, Italy, December 2001.

PARTICIPATION TO CONFERENCES AND MEETINGS

2007: NanotechInsight 07, Luxor, Egypt (invited)
2006: Gordon Research Conferences "Electronic Processes In Organic Materials"
Mount Holyoke College South Hadley, MA.
2005: MRS, Fall Meeting, Boston (I had to withdraw my accepted abstract for an oral presentation because of the coincidence with the due date for the birth of my baby).
2005: European conference of Molecular Electronics; Bologna, Italy.
2004: Photonics Europe 2004, Strasbourg, France (oral presentation).
2002: International Conference Of Raman Spectroscopy, Budapest, Hungary (oral presentation).
2001: Annual Meeting of the International Energy Agency - Hydrogen-Annex 14, Uppsala, Sweden (oral presentation).
2000: 13th International Conference on Photochemical Conversion and Storage of Solar Energy, Snowmass, Colorado, USA.
1998: 12th International Conference on Photochemical Conversion and Storage of Solar Energy, Berlin, Germany.
1996: International Union of Pure and Applied Chemistry, Geneva, CH.
1995: Journées d'Electrochimie, Grenoble, France
I co-authored about 20 posters presented at peer-reviewed international conferences.

REVIEWER ACTIVITY

I am referee for the journals: *Journal of Physical Chemistry*, *Acta Materialia*, *Journal of Materials Research*, *Applied Surface Science* and *Journal of Material Science*.

SOCIETY MEMBERSHIP

I am a member of the American Chemical Society.

LANGUAGES

Italian

French and English

German, Portuguese, Spanish

Mother tongue

Excellent (written and spoken)

Basic knowledge