

CINZIA CRISTIANI – PROFESSORE DI II FASCIA – POLITECNICO DI MILANO, DIPARTIMENTO DI CHIMICA, MATERIALI E INGEGNERIA CHIMICA

Personal Data

Name: Cinzia

Surname: Cristiani

Date of birth: 19/01/1959

Organization and Position: Politecnico di Milano, Associate Professor

Education and training

1984 - Graduated in Chemistry at Università degli Studi di Pavia.

1990 - PhD degree in Industrial Chemistry, discussing a research work on "Direct synthesis of methanol and higher alcohols from CO and H₂: preparation, activation and characterization of modified methanol catalysts operating at high temperatures".

Since 1992 she is permanent staff at Politecnico di Milano, Dipartimento di Chimica, Materiali ed Ingegneria Chimica "G. Natta".

Since 2002 she is associate professor at Politecnico di Milano, School of Industrial Processes Engineering.

She is teacher of the courses "Microbiologia Industriale (Industrial Microbiology)" and "Functional

Ceramics Materials" for the 2nd level degree in "Chemical Engineering" and "Materials Engineering and Nanotechnology".

Her past research activity has mainly regarded the preparation and the characterization of heterogeneous catalysts for energy production and environmental protection.

Her present research activity regards preparation and characterization of materials for: 1) both solid oxides (SOFCs) and Polymer Electrolyte Membrane (PEM-FCs) fuel cells application, 2) organoclays (hybrid organic-inorganic materials) for environmental applications and circular economy, and 3) coating deposition for structured catalysts production.

Projects in which she has been and is involved:

1) Progetto Cariplo "Advanced material for Gas Diffusion Electrodes (GDE) in polymer electrolytes membranes fuel cells" (24 months) leader; 2) Progetto PRIN Intensificazione di Processi Catalitici per Energia Pulita, Trasporti a Basse Emissioni e Chimica Sostenibile usando Schiume a Celle Aperte quali Nuovi Materiali Strutturati Avanzati (IFOAMS)" 36 months unit participant, 3) Progetto PRIN "Sviluppo di catalizzatori Rh-supportati nanodispersi per la produzione di miscele H₂/CO mediante ossidazione parziale di gas naturale" 24 months, participant; 4) Progetto PRIN "Sviluppo di catalizzatori e reattori strutturati per la produzione di idrogeno mediante ossidazione parziale diretta di idrocarburi leggeri" 24 months participant, 5) Progetto PRIN "Catalizzatori a base di palladio supportato per combustione di metano in condizioni magre" 24 month, participant. 6) FREECATS Nol (Project Number 15054, duration 1.2016 - 12.2018, EIT Raw Materials), participant; 7) BloW UPRIS (Project Number 16320, duration 4.2017 - 3.2019, Unit coordinator); 8) RM@Schools3.0, Unitl coordinator. Since January 2018 she is Raw Materials Ambassador within the project RM@Schools3.0

SURVAY OF CINZIA CRISTIANI ACTIVITY YEARS 2016-18.

Teaching activity and students evaluation

Course: 093563 - FUNCTIONAL CERAMIC MATERIALS

(Scaglioni da manifesto: Ing. Ind-Inf (1 liv.)(ord. 270) - MI (347) Ingegneria Chimica, Ing. Ind-Inf (Mag.)(ord.

270) - MI (472) Chemical Engineering - Ingegneria Chimica, Ing. Ind-Inf (Mag.)(ord. 270) - MI (491) Materials Engineering and Nanotechnology - Ingegneria dei Materiali e delle Nanotecnologie

AY	N° students	Students Evaluation	School Average
2015-16	63	3,07/4	3,10
2016-17	42 (*)	3,36/4	3,10
2017-18	36 (*)	3,1/4	3.09

(* low number of students depends on courses overlapping)

Course 093555 - MICROBIOLOGIA INDUSTRIALE (MODULI: 093553 PROCESSI BIOLOGICI INDUSTRIALI E 093554 FONDAMENTI DI PROCESSI BIOLOGICI)

(Scaglioni da manifesto: Ing. Ind-Inf (1 liv.)(ord. 270) - MI (347) Ingegneria Chimica, Ing. Ind-Inf (Mag.)(ord.

270) - MI (472) Chemical Engineering - Ingegneria Chimica)

AY	N° students	Students Evaluation	School Average
2015-16	18 (*)	3,46/4	3,1
2016-17	42	3,44/4	3.1
2017-18	55	3.7/4	3.1

(*numero studenti legato a problemi di orario, principalmente sovrapposizione)

Thesis tutoring 2016-2018

- **Master:** 9 master thesis in in Chemical Engineering and Materials Engineering and Nanotechnology
- **I Level:** 15 thesis in Ingegneria Chimica e Ingegneria dei Materiali e Nanotecnologie
- **PhD:** 1 thesis in Chemical Engineering e 2 thesis in Materials Engineering and Nanotechnology

Other activities AY 2016-18: Member of the “Commissione di tutorato” for Chemical Engineering (I and II Level) and Materials Engineering and Nanotechnology ngegneria dei materiali e Nanotecnologie (I e II Livello)

Scientific activity, publications and bibliometric indexes 2016-2018

List of papers (2015-2018) and bibliometric related indexes:

h index 32 (self and ALL Authors citations excluded h index 30); total citation number: 711 (self and ALL Authors citations excluded 622)

2018

1) Ambrosetti, M., Balzarotti, R., Cristiani, C., Groppi, G., Tronconi, E., *The influence of the washcoat deposition process on high pore density open cell foams activation for CO catalytic combustion*, (2018) Catalysts, 8 (11), art. no. 510, DOI: 10.3390/catal8110510, Access Type: Open Access

2) Ceccarelli, L., Bellotto, M.P., Caruso, M., Cristiani, C., Dotelli, G., Gallo Stampino, P., Gasti, G., Primavesi, L., *Characterization of clays and the technology of Roman ceramics production*, (2018) Clay Minerals, 53 (3), pp. 413-429. DOI: 10.1180/clm.2018.30

3) Iannicelli-Zubiani, E.M., Gallo Stampino, P., Cristiani, C., Dotelli, G., *Enhanced lanthanum adsorption by amine modified activated carbon*, (2018) *Chemical Engineering Journal*, 341, pp. 75-82. DOI: 10.1016/j.cej.2018.01.154

4) Cordaro, G., Donazzi, A., Pelosato, R., Cristiani, C., Dotelli, G., Sora, I.N., *Copper Doped La_{0.8}Sr_{1.2}FeO₄ Ruddlesden-Popper SOFC Cathode: Synthesis, Characterization and Model Analysis*, (2018) *Fuel Cells*, 18 (1), pp. 27-41. DOI: 10.1002/fuce.201700103

5) Latorrata, S., Basso Peressut, A., Stampino, P.G., Cristiani, C., Dotelli, G., *Preliminary study on the development of sulfonated graphene oxide membranes as potential novel electrolytes for PEM fuel cells*, (2018) *ECS Transactions*, 86 (13), pp. 347-356. DOI: 10.1149/08613.0347ecst

6) Latorrata, S., Gallo Stampino, P., Scandola, L., Cristiani, C., Dotelli, G., *Analysis of degradation mechanisms and durability assessment of graphene-based MPLS for PEM fuel cells*, (2018) *ECS Transactions*, 86 (13), pp. 337-345. DOI: 10.1149/08613.0337ecst

7) Latorrata, S., Pelosato, R., Stampino, P.G., Cristiani, C., Dotelli, G., *Use of electrochemical impedance spectroscopy for the evaluation of performance of PEM fuel cells based on carbon cloth gas diffusion electrodes*, (2018) *Journal of Spectroscopy*, DOI: 10.1155/2018/3254375, Access Type: Open Access

2017

8) Balzarotti, R., Cristiani, C., Francis, L.F., *Spin coating deposition on complex geometry substrates: Influence of operative parameters*, (2017) *Surface and Coatings Technology*, 330, pp. 1-9. DOI: 10.1016/j.surfcoat.2017.09.077

9) Latorrata, S., Stampino, P.G., Cristiani, C., Dotelli, G., *Performance evaluation and durability enhancement of FEP-based gas diffusion media for PEM fuel cells*, (2017) *Energies*, 10 (12), DOI: 10.3390/en10122063 Access Type: Open Access

10) Viganò, F., Cristiani, C., Annoni, M., *Ceramic sponge Abrasive Waterjet (AWJ) precision cutting through a temporary filling procedure*, (2017) *Journal of Manufacturing Processes*, 28, pp. 41-49, DOI: 10.1016/j.jmapro.2017.05.014

11) Iannicelli-Zubiani, E.M., Cristiani, C., Dotelli, G., Stampino, P.G., Pelosato, R., Finocchio, E., *Effect of pH in the synthesis of organo-clays for rare earths removal*, (2017) *Environmental Engineering and Management Journal*, 16 (8), pp. 1719-1728.

12) Cordaro, G., Donazzi, A., Pelosato, R., Cristiani, C., Dotelli, G., Natali Sora, I., *Electrochemical and chemical characterization of NdBa_{1-x}Co_{2-y}FeyO_{5+δ} cathodes for IT-SOFCs*, (2017) *ECS Transactions*, 78 (1), pp. 507-520. DOI: 10.1149/07801.0507ecst

13) Iannicelli-Zubiani, E.M., Cristiani, C., Dotelli, G., Gallo Stampino, P., *Recovery of valuable metals from electronic scraps by clays and organo-clays: Study on bi-ionic model solutions*, (2017) *Waste Management*, 60, pp. 582-590. DOI: 10.1016/j.wasman.2016.07.035

14) Iannicelli-Zubiani, E.M., Giani, M.I., Recanati, F., Dotelli, G., Puricelli, S., Cristiani, C., *Environmental impacts of a hydrometallurgical process for electronic waste treatment: A life cycle assessment case study*, (2017) *Journal of Cleaner Production*, 140, pp. 1204-1216. DOI: 10.1016/j.jclepro.2016.10.040

2016

15) Italiano, C., Balzarotti, R., Vita, A., Latorrata, S., Fabiano, C., Pino, L., Cristiani, C., *Preparation of structured catalysts with Ni and Ni-Rh/CeO₂ catalytic layers for syngas production by biogas reforming processes*, (2016) *Catalysis Today*, 273, pp. 3-11. DOI: 10.1016/j.cattod.2016.01.037

16) Balzarotti, R., Italiano, C., Pino, L., Cristiani, C., Vita, A. *Ni/CeO₂-thin ceramic layer depositions on ceramic monoliths for syngas production by Oxy Steam Reforming of biogas*, **(2016)** Fuel Processing Technology, 149, pp. 40-48. DOI: 10.1016/j.fuproc.2016.04.002

17) Balzarotti, R., Cristiani, C., Latorrata, S., Migliavacca, A., *Washcoating of low surface area cerium oxide on complex geometry substrates*, **(2016)** Particulate Science and Technology, 34 (2), pp. 184-193. DOI: 10.1080/02726351.2015.1058872

18) Ferrari, M., Dalola, S., Ferrari, V., Cordaro, G., Cristiani, C., *Mask-Less Direct-Writing Deposition of Lead-Free Piezoelectric Films for Microsystems*, **(2016)** Procedia Engineering, 168, pp. 1196-1199. DOI: 10.1016/j.proeng.2016.11.409, Access Type: Open Access

Short summary of the scientific activity related to topics

1) Coating deposition of thin ceramic layers on geometrical substrates [1,8,10,15-17]

Deposition of thin ceramic layers on geometrical substrates is a very interesting research topic, in view of many fields of application. Among them, process intensification has recently reached wide attention by both the technological and scientific community. In particular, monoliths and open cell foams have been proposed for syngas production in steam reforming process. The research activity regarded the development of acid-free stable oxide dispersions has been studied to obtain thin oxide layers onto substrates of complex geometry to obtain structured catalysts and reactors for process intensification. In particular, high and low surface area model catalysts were selected, and their powders were deposited via dip- and spin-coating deposition technique. Ceramic monoliths were used as structured supports. Slurry formulations, including powder dispersant and stabilizers were studied in order to obtain the proper rheological behavior and stability of the suspension. Results were evaluated in terms of coating load and adhesion performance. Final coating loads of about 18 %wt. were obtained performing multiple depositions. A good homogeneity of the washcoat layers was found, accompanied by a quite good adhesion (6% wt of coating loss after ultrasound treatment).

2) Archeometrical study of the technology of Roman ceramics production [2]

The recent discovery of a Roman ceramics manufacturing workshop at Montelabate (Perugia, Italy), in use from the first century BC until the late-fourth to fifth centuries AD, offers a unique opportunity to study the technical processes for producing Roman amphorae. Ancient and modern clays were sampled and analysed; they do not differ significantly, supporting the hypothesis of the exploitation of the rich local clay source that allowed a continuity of production. Characterization of the clays was performed using geotechnical methods (Atterberg limits and size distribution) and by thermogravimetric and differential thermogravimetric analysis, Fourier-transform infrared spectroscopy, X-ray diffraction and X-ray fluorescence analyses. The material was suitable for pottery making with the addition of calcite and quartz sand temper. Production waste and discarded materials as well as good-quality products were also analysed with the same methodology. It is therefore possible to reconstruct the ancient technology by defining the recipe for the production of the amphorae and their firing temperature on the basis of the decomposition of clay materials and the presence of newly formed minerals.

3) Recovery of Rare Earths and Precious Metals from WEEE (Waste Electrical and Electronic Equipment) by acid leaching and immobilized agents [3, 11-14]

Today there is an increasing need for rare earths (REs) due to their usage in numerous high-technology applications such as: optical, electronics, ceramics and nuclear. Currently each EU citizen produces about 17 kg of waste electrical and electronic equipment (WEEE) per year. These wastes are rich in precious and strategic metals and, in many cases, are characterized by higher REs contents than those of natural minerals. Accordingly, recycling can be considered a valuable opportunity: this perspective is known as "urban mining". For these reasons, the study of a targeted and efficient REs recovery from WEEE can only

lead to undeniable both socio-economic and environmental benefits. Two natural smectite mineral clays (STx and SWy) were studied for lanthanum (chosen as representing element of REs family) adsorption and release in order to: 1) verify the clays sorption capability, 2) investigate the sorption mechanisms and 3) optimize the experimental parameters, such as contact time and pH. In order to increase the global efficiency of the process, different polyamines were intercalated in the clay interlayer and tested. Lanthanum recovery global efficiency, achieving values around 85% (99.9% in uptake, 84% in release) was reached. Then a different solid matrix was considered: activated carbon was tested as sorbent material. Also in this case the modification of the solid was carried out with a linear ethylene amine obtaining huge increase in the lanthanum recovery global efficiency, achieving values around 90% (99.9% in uptake, 90% in release). A preliminary analysis about the sustainability of the global WEEE treatment was also carried out showing the great environmental benefits of the proposed process.

4) Solid Oxides Fuel Cells [4,12]

The quest for electrode materials capable of attaining good electrochemical performances in Intermediate Temperature Solid Oxide Fuel Cells (IT-SOFCs) is a key research. Novel material composition have been experienced. Namely, Neodymium- and cobalt-based layered perovskite oxides with increasing Ba deficiency ($\text{NdBa}_{1-x}\text{Co}_2\text{O}_{5+d}$, $x = 0.0-0.2$) firing and $\text{La}_{0.8}\text{Sr}_{1.2}\text{Fe}_{0.9}\text{Cu}_{0.1}\text{O}_{4+d}$ (LSFC). The chemical and electrochemical properties of these materials were characterized via XRD, SEM, TG-DTA, 4-probe conductivity measurement and EIS tests on symmetric cells. The maximum tolerated Ba deficiency is slightly below 10%. Structural refinement of the obtained compound was performed in order to analyze a structure- electrochemical performance correlation. Preparation methodology and composition were found to be fundamental for the achievement of the material performances when operated in the cell.

5) Polymer electrolyte membrane fuel cells (PEMFCs) [5-7, 9]

Polymer electrolyte membrane fuel cells (PEMFCs) have attracted great attention in the last two decades as valuable alternative energy generators because of their high efficiencies and low or null pollutant emissions. In particular, gas diffusion electrodes (GDEs) are key components for PEMFCs function. In the GDEs assembly it is required the presence of a GDM (Gas Diffusion Medium), for an efficient control of both gas distribution and water management. GDM consists of a macro-porous substrate, usually a carbon cloth or carbon paper, coated with a thin Micro-Porous Layer (MPL). Traditionally, PTFE is used as hydrophobic agent and binder. The research activity, related papers published in the years under evaluation, has regarded the evaluation of the influence on the performance of the cell when operated in near to real conditions of: 1) replacement of PTFE with innovative fluorinated polymers (polytetrafluoroethylene-co-hexafluoro-propylene (FEP), polytetrafluoroethylene-co-perfluoroalkoxy vinyl ether (PFA), a fluorinated polyurethane based on perfluoropolyether blocks (PFPE) and a commercially available Fluorolink® P56 (Solvay Specialty Polymers, Milan, Italy), and 2) the effect of the coating procedure, both in presence or of Pt as catalyst, on the final cell performances 3) the effect of the presence of carbon nanotubes CNTs (10% wt) to push power density and cell efficiency 4) the durability of the cell when ad-hoc accelerated stress tests, both chemical and mechanical, are performed on GDMs 5) the use of carboxymethylcellulose (CMC) as viscosity modulator to control rheological behavior of the carbon-based inks used for coating.

Projects and grants (2016-2018)

1) Unit Coordinator:

BloW-uP BloW-uP Balkans Waste to Products: transfer of Nol model to Balkan area: de-siloling new waste-derived raw materials and developing new applications (INTERNAZIONALE)

RAISESEE Raw Materials Students Internships in East South East Europe (EIT RIS activity related to action line I), (INTERNAZIONALE)

RM@Schools3.0 Raw Matters Ambassadors at Schools 3.0 (INTERNAZIONALE)

2) Participant:

FREECATS Critical raw materials-FREE CATalystS (INTERNAZIONALE)

FOODTECH Prodotti innovativi in campo zootecnico (NAZIONALE)

E-WASTE E-WASTE il ciclo intelligente (NAZIONALE)

GRAFENE (NAZIONALE)

Lista delle pubblicazioni nel triennio 2015-18 e Indicatori bibliometrici ad esso riferiti:

h index 32 (self and ALL Authors citations excluded h index 30); total citation number: 711 (self and ALL Authors citations excluded 622)

2018

19) Ambrosetti, M., Balzarotti, R., Cristiani, C., Groppi, G., Tronconi, E., *The influence of the washcoat deposition process on high pore density open cell foams activation for CO catalytic combustion*, (2018) Catalysts, 8 (11), art. no. 510, DOI: 10.3390/catal8110510, Access Type: Open Access

20) Ceccarelli, L., Bellotto, M.P., Caruso, M., Cristiani, C., Dotelli, G., Gallo Stampino, P., Gasti, G., Primavesi, L., *Characterization of clays and the technology of Roman ceramics production*, (2018) Clay Minerals, 53 (3), pp. 413-429. DOI: 10.1180/clm.2018.30

21) Iannicelli-Zubiani, E.M., Gallo Stampino, P., Cristiani, C., Dotelli, G., *Enhanced lanthanum adsorption by amine modified activated carbon*, (2018) Chemical Engineering Journal, 341, pp. 75-82. DOI: 10.1016/j.cej.2018.01.154

22) Cordaro, G., Donazzi, A., Pelosato, R., Cristiani, C., Dotelli, G., Sora, I.N., *Copper Doped La_{0.8}Sr_{1.2}FeO₄ Ruddlesden-Popper SOFC Cathode: Synthesis, Characterization and Model Analysis*, (2018) Fuel Cells, 18 (1), pp. 27-41. DOI: 10.1002/fuce.201700103

23) Latorrata, S., Basso Peressut, A., Stampino, P.G., Cristiani, C., Dotelli, G., *Preliminary study on the development of sulfonated graphene oxide membranes as potential novel electrolytes for PEM fuel cells*, (2018) ECS Transactions, 86 (13), pp. 347-356. DOI: 10.1149/08613.0347ecst

24) Latorrata, S., Gallo Stampino, P., Scandola, L., Cristiani, C., Dotelli, G., *Analysis of degradation mechanisms and durability assessment of graphene-based MPLS for PEM fuel cells*, (2018) ECS Transactions, 86 (13), pp. 337-345. DOI: 10.1149/08613.0337ecst

25) Latorrata, S., Pelosato, R., Stampino, P.G., Cristiani, C., Dotelli, G., *Use of electrochemical impedance spectroscopy for the evaluation of performance of PEM fuel cells based on carbon cloth gas diffusion electrodes*, (2018) Journal of Spectroscopy, DOI: 10.1155/2018/3254375, Access Type: Open Access

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26) Balzarotti, R., Cristiani, C., Francis, L.F., *Spin coating deposition on complex geometry substrates: Influence of operative parameters*, (2017) Surface and Coatings Technology, 330, pp. 1-9. DOI: 10.1016/j.surfcoat.2017.09.077

27) Latorrata, S., Stampino, P.G., Cristiani, C., Dotelli, G., *Performance evaluation and durability enhancement of FEP-based gas diffusion media for PEM fuel cells*, (2017) Energies, 10 (12), DOI: 10.3390/en10122063 Access Type: Open Access

28) Viganò, F., Cristiani, C., Annoni, M., *Ceramic sponge Abrasive Waterjet (AWJ) precision cutting through a temporary filling procedure*, (2017) Journal of Manufacturing Processes, 28, pp. 41-49, DOI: 10.1016/j.jmapro.2017.05.014

29) Iannicelli-Zubiani, E.M., Cristiani, C., Dotelli, G., Stampino, P.G., Pelosato, R., Finocchio, E., *Effect of pH in the synthesis of organo-clays for rare earths removal*, (2017) Environmental Engineering and Management Journal, 16 (8), pp. 1719-1728.

30) Cordaro, G., Donazzi, A., Pelosato, R., Cristiani, C., Dotelli, G., Natali Sora, I., *Electrochemical and chemical characterization of NdBa_{1-x}Co_{2-y}FeyO_{5+δ} cathodes for IT-SOFCs*, (2017) ECS Transactions, 78 (1), pp. 507-520. DOI: 10.1149/07801.0507ecst

31) Iannicelli-Zubiani, E.M., Cristiani, C., Dotelli, G., Gallo Stampino, P., *Recovery of valuable metals from electronic scraps by clays and organo-clays: Study on bi-ionic model solutions*, (2017) Waste Management, 60, pp. 582-590. DOI: 10.1016/j.wasman.2016.07.035

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34) Balzarotti, R., Italiano, C., Pino, L., Cristiani, C., Vita, A. *Ni/CeO₂-thin ceramic layer depositions on ceramic monoliths for syngas production by Oxy Steam Reforming of biogas*, **(2016)** Fuel Processing Technology, 149, pp. 40-48. DOI: 10.1016/j.fuproc.2016.04.002

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36) Ferrari, M., Dalola, S., Ferrari, V., Cordaro, G., Cristiani, C., G., *Mask-Less Direct-Writing Deposition of Lead-Free Piezoelectric Films for Microsystems*, **(2016)** Procedia Engineering, 168, pp. 1196-1199. DOI: 10.1016/j.proeng.2016.11.409, Access Type: Open Access

F) PROGETTI triennio 2016-2018

1) RESPONSABILE DI UNITA':

BloW-uP BloW-uP Balkans Waste to Products: transfer of Nol model to Balkan area: de-siloling new waste-derived raw materials and devel-oping new applications (INTERNAZIONALE)

INTENSIFIC INTENSIFICAZIONE DI PROCESSI CATALITICI PER ENERGIA PULITA (NAZIONALE)

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GRAFENE (NAZIONALE)