



PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 39th cycle

**PNRR 118 PNRR Research Field: PHOTOCATALYTIC MATERIALS FOR ENVIRONMENTAL
CLEANUP**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Environmental pollution represents a serious concern for our industrialized society, due to the discharge of several hazardous substances in natural streams and in the atmosphere. These pollutants have demonstrated to have a strong negative impact on the environment, leading to harmful effects on the biological equilibrium of the ecosystem and on human health. In the last years the adoption of strict rules, especially in the European Union, has allowed to decrease the concentration of harmful pollutants ahead their discharge by banishing many of the pollution sources or by imposing wastewater and air treatments. In this context, the research of treatments for the abatement of pollution in wastewaters and air has attracted an increasing attention from the scientific community. Among the several developed methods, heterogeneous photocatalysis, one of the most studied Advanced Oxidation Processes (AOPs), has demonstrated to be a promising technique for the removal of organic pollutants both in liquid and in gas phase, since it can lead to the complete mineralization of these substances at ambient conditions by exploiting solar energy.

In particular, titanium dioxide (TiO₂) has gained attention as photocatalyst due to its high stability in different pH ranges, environmental sustainability, relatively low cost, and non-toxicity; moreover, its bandgap properties and high conductivity of the photogenerated electrons and holes allow reaching a high photodegradation efficiency



	under UV-A exposure. The aim of this research is to utilize nanostructured TiO₂ photocatalysts for environmental cleanup, by proposing testing conditions getting closer to real effluents the material would encounter in practical applications.
Methods and techniques that will be developed and used to carry out the research	The research will be conducted by using two main techniques for photocatalyst production, i.e., anodic oxidation to grow immobilized structures on metallic substrates, and sol-gel to deposit coatings on substrates of various composition. The produced materials will be characterized from the morphological and structural point of view with conventional techniques, such as SEM, XRD, Raman, XPS, TEM. Although the main photocatalyst tested will be titanium dioxide, co-catalysts will be considered to improve photocatalytic efficiency. Specifically, quantum dots of various composition (e.g., tellurides, selenides, sulfides) as well as noble metal nanoparticles (Au, Pt) will be added and characterized. Both liquid and gas phase photocatalysis tests will be adopted, to understand where these materials could represent the best advantage in pollutants degradation. In this frame, the collaboration with CIEMAT will allow a deeper evaluation compared with the facilities available at the research group at Politecnico di Milano, ensuring a wider set of experimental conditions and pollutants to investigate.
Educational objectives	The candidate will develop a deep theoretical and experimental experience in air and water photocatalytic purification strategies, as well as on the production of hybrid photocatalysts, and a good knowledge on other processes related with advanced oxidation.
Job opportunities	The experience accumulated in the 3 years will grant access to R&D departments in the field of electrochemistry, purification devices and technologies, and synthesis and characterization of nanomaterials for energy and environmental remediation.
Composition of the research group	2 Full Professors 3 Associated Professors 2 Assistant Professors



	2 PhD Students
Name of the research directors	Prof. M.V. Diamanti, Prof. MP. Pedeferri

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	
By number of months at the company	0
Institution or company where the candidate will spend the period abroad (name and brief description)	Departamento de Energía del Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT). Avda. Complutense 40, 28040 - Madrid, España http://fotoair.ciemat.es/
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Individual budget for research (5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd year: 1.900 euro Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student): there are various forms of financial for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.