POLITECNICO DI MILANO

PhD in FISICA / PHYSICS - 39th cycle

THEMATIC Research Field: DEVELOPMENT OF ULTRAFAST ALL-OPTICALLY TUNABLE METASURFACES FOR TRANSIENT STRONG COUPLING

Monthly net income of PhDscholarship (max 36 months)
€ 1225.0 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	The Research is funded by Project ULYSSES, grant agreement no. 101077181. The main objective of the research is the development of a novel class of photonic metasurfaces with all-optically tunable high quality-factor resonances. The motivation behind this goal is the possibility to operate such devices as ultracompact nanocavities with unprecedented reconfigurability in terms of speed and localization of intense near fields, when excited with femtosecond laser pulses. This platform will potentially enable a dynamical control of light-matter strong coupling on the sub-picosecond time scale. If successful, the achievement will open for a new frontier of research in physical chemistry: the manipulation of photoinduced chemical processes by reshaping of transition states.
Methods and techniques that will be developed and used to carry out the research	The working methods and techniques of the planned activity will mainly concern: - The theoretical study of hot-electron based nonlinearity in nanomaterials, including semiconductor and/or plasmonic media. - The development of reduced models for the electromagnetic response of optically reconfigurable metasurfaces via third-order nonlinear effects. - The integration of these models into commercial tools for finite element numerical analysis of the full-vectorial electromagnetic response of photonic nanocavities. - The optimization of manufacturing parameters (using, for example, inverse design techniques and machine

	learning) aimed at maximizing and tailoring the local near-fields at the metasurface for efficient coupling with chemical species to be selected. - The validation and testing of the fabricated metasurface samples via pump-probe optical spectroscopy experiments.
Educational objectives	The PhD candidate will work in a multidisciplinary team including top researchers in theoretical photonics, nonlinear nanophotonics, ultrafast spectroscopy, and nanomaterials manufacturing. He/she will learn state-of-the-art of optical metasurfaces, computational methods in nanophotonics and advanced spectroscopy techniques.
Job opportunities	Job opportunities will be in companies that design and develop novel photonic materials, devices and systems with high degree of integration, with a broad impact on next generation telecommunications and energy harvesting technologies.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 1 PhD Students
Name of the research directors	Giuseppe Della Valle, Margherita Maiuri

Contacts
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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	612.5 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities:Educational activitiespurchase of study books and material, funding for participation to courses, summer schools, workshops and conferences). Financial aid per PhD student per 3 years: max 4.993,35 euros per student.

Teaching assistantship:There are various forms of financial aid 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 regulations.

Computer availability: *individual use*

Desk availability: *individual use*