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Pozvánka na přednášku

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Photonic and plasmonic multilayer metastructures with tunable properties based on alternative plasmonic nanomaterials

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Abstract: Plasmonics is currently at the forefront of materials science research because it allows tailoring and intensification of light-matter interaction at the nanoscale. However, the demand to extend the excitation range and tune the plasmonic response, at synthesis or with external stimuli, drove the research towards alternative materials with respect to noble metals, for application in fields ranging from sensing, photocatalysis and solar fuel production to photovoltaics, telecommunications and optoelectronics. Transparent Conductive Oxides (TCO) and transition metal nitrides are appealing materials in this context, and can be employed as building elements for artificial metamaterials with unique novel functionalities.
In this talk we discuss how the properties of thin and ultrathin films of alternative materials, i.e. titanium nitride or oxynitride (TiN or TiOxNy) and TCO Ta-doped TiO_2, can be tuned and modulated by acting on doping, stoichiometry, nanostructure and nanoscale morphology, and how they can be integrated in multilayer metastructures with original design routes via pulsed laser deposition. The goal is to explore potentialities resulting from unusual combinations of materials and properties (transparency, electrical conductivity, tunable VIS-NIR plasmonics, active modulation).
First, we show how the electrical/optical properties of Ta:TiO_2 films can be finely tuned at the synthesis stage, down to ultrathin films, and we show how acting on stoichiometry can lead to a tunable plasmonic response in the case of TiN and epsilon near-zero (ENZ) behavior in the case of TiO_xN_y.
Then, we discuss the integration of these materials in multifunctional metamaterial structures. For instance, Au nanoparticles (NP) embedded in Ta:TiO_2 show the possibility to modulate the NP Localized Surface Plasmon Resonance, while transparent conducting 1D photonic crystals based on Ta-doped TiO2 have been obtained in a simple one-step synthesis, by alternating conductive and dielectric layers; thanks to the possibility of electro-optical doping, we show that the photonic band gap in the visible spectrum can be actively modulated with an external bias. Finally, novel TiN-TiO2 plasmonic multilayers have been realized as hyperbolic meta-systems showing thermal stability and fabrication compatibility typical of TiN.

Andrea Li Bassi obtained a degree summa cum laude in Nuclear Engineering at Politecnico di Milano in 1997 and a Ph.D. in Condensed Matter Physics at Durham University (UK) in 2000. He is currently full professor of Physics of Matter at Politecnico di Milano. He lectured in several courses in the field of physics, physics of condensed matter and nanotechnology and currently lectures Solid State Physics and Nanomaterials for Energy Conversion to M.Sc. students. He is responsible of research activities at Nanolab and coordinator of the Chemical Technologies, Processes and Nanotechnology division, Department of Energy. His current research interests focus on the development of nanostructured thin films for photoconversion, plasmonics, sensing and energy applications, the investigation of 2D materials and nanostructures and the study of carbon and metal oxide nanostructures. He is author of more than 170 scientific papers on peer reviewed journals (h-index 48 - Google Scholar, 42 - Web of Science) and has been PI or local coordinator in several funded research projects.