BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

Ammin/DISAT - Modulation of Enzymatic Activity via Plasmonic Hot Spots

Funded By	Dipartimento DISAT Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	RNA viruses are a class of pathogens causing significant morbidity and mortality worldwide. Their high mutation rates can enable zoonotic spillover and lead to pandemics. At the basis of the high mutation rates, lies the RNA polymerase, an enzyme responsible for transcription and replication. Recently, it has been shown that the integration of gold nanoparticles with enzymes can enable the modulation of enzymatic activity via light absorption. The student will work on testing the hypothesis that the illumination of hot spots in gold nanostars can be leveraged to modulate activity and fidelity of IAV's RNA polymerase through the generation of photothermal heat and hot electrons. Bando FARE - progetto PHROGS 1216/2022 Modulazione Plasmonica Mediata da Hot Spot dell'Attività dell'RNA Polimerasi Virale Indagata Tramite Surface Enhanced Raman Spectroscopy – CUP E13C22002520005.
	We will build a plasmonic platform in which gold nanostars will be grown in situ in an organized array, thus bridging the gap between top-down and bottom-up nanomanufacturing protocols, and where IAV RNA polymerase will be covalently anchored at the nanostar tips with ligands that are resistant to the reaction conditions in which RNA replication occurs. To understand the activity of the enzyme once bound to the nanoparticles and exposed to light, detailed mechanistic studies need to be carried out to unravel the fundamental laws of plasmonic biocatalysis. The results obtained and the fundamental knowledge generated will inform the design of novel photocatalysts based on the integration of hot electron-producing plasmonic nanoparticles. The student will be responsible for: 1. Growing plasmonic nanoparticles in solution and learn how to conjugate enzyme molecules onto them; 2. Understanding how to modulate the activity of enzymes correlating them to the enzyme's morphological changes occurring upon interaction with the

Objectives	nanoparticles; 3. Understanding the mechanisms with which heat and hot electrons affect the enzymatic activity when the enzymes are bound to plasmonic nanoparticles. In particular, the student will: 1. Design, synthesize, and characterize gold nanoparticles of various morphologies in solution; 2. Design and optimize methods to stably and reproducibly bind the enzyme molecules to gold nanoparticles so they can be equally modulated by light and heat; 3. Implement experimental methodologies to characterize the properties of the enzyme-nanoparticle systems and how these properties are affected by plasmon-mediated illumination, which generates heat and hot electrons. 4. Analyze the obtained data with innovative statistical methods; 5. Model computationally the plasmonic response of the nanoparticles through the software Comsol Multiphysics. 6. Coherently organize and report the data collected for presentation to the other group members, collaborators, and/or audiences at conferences.

Skills and competencies for the development of the activity	We are looking for talented and driven students with preferably a M.S. degree in chemistry or materials science (broadly defined) and previous expertise in: 1. Basic knowledge on synthesis and functionalization of nanoparticles; 2. Basic knowledge of optical spectroscopy; 3. Basic knowledge of conjugation chemistry; 4. Basic knowledge of catalysis and enzymatic activity.