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All-dielectric nanophotonics with van der Waals materials

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ABSTRACT: High refractive index dielectrics emerged as an exciting nanophotonic platform to shape and control electromagnetic fields at the nanoscale, for tailoring the light-matter interaction of solid-state emitters. Van der Waals (vdW) materials, such as the family of Transition Metal Dichalcogenides (TMDs), are a powerful system to investigate light-matter interaction at the nanoscale, exhibiting exceptional optical properties in their monolayer form, with tightly bound excitons, light–valley degrees of freedom, and single-photon sources. Moreover, in their bulk form, TMDs exhibit large refractive indexes (n>4) and strong optical anisotropy, making them a favourable candidate for the realization of low-losses optical resonances in all-dielectric TMD nanophotonic structures.

Here, we show that coupling TMD monolayers with Mie resonances in dielectric nanoantennas opens to enhancement of light-matter interaction of 2D excitons and quantum efficiency enhancement of native strain-induced single-photon emitters. Furthermore, we introduce how nanophotonic structures, made exclusively of vdW materials, open to a plethora of possibilities for control light at the nanoscale, from single antennas for unidirectional emission, to collective resonator arrays, or metasurfaces, sustaining high quality factor resonances empowered by photonic bound states in the continuum.

Short BIO: I am Luca Sortino, a post-doctoral researcher in low-dimensional nanomaterials and nanophotonics. My research focuses on the interaction between light and matter at the nano-scale. More specifically, I study the optical properties of low-dimensional quantum materials and their interaction with optical cavities. I obtained a MSc at the Material Science department at University of Bicocca Milan, Italy, in 2016. Here, I studied the optical properties of inorganic perovskite nano-crystals and started my way into the techniques of optical spectroscopy. I have then moved to Sheffield in the 2D material sub-group within the Low Dimensional Structures & Devices Group in the faculty of Physics. I obtained my PhD in early 2020 at the University of Sheffield, as part of the International Training Network (ITN) Spin-NANO founded by Marie Skłodowska Curie Actions. Here I have expanded my research of quantum materials with 2D semiconductors. The main fields covered by my doctorate are the excitonic physics in 2D materials and single photon emitters, with focus on experimental quantum optics.

In October 2020 I obtanied a new position as a postdoc researcher in the Hybrid Nanophotonics group led by Prof. Stefan Maier at the Ludwig-Maximilians-Universität (LMU) in Munich, where I started to develop expertise in ultrafast spectrosocopy, and research in plasmonics and optical metasurfaces. In May 2022 I started a new journey in the same group with an Alexander von Humboldt Research Fellowship.

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