Hybrid Inorganic/Organic Systems
for Opto-Electronics
Collaborative Research Centre 951

HIOS

# Colloquium Announcement

## of the Collaborative Research Centre 951
## "Hybrid Inorganic/Organic Systems for Opto-Electronics"


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## Integrated single molecule devices for quantum photonic technologies

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## Revealing fine details of nano-plasmonics using monochromated electrons

Time: Thursday, 26.11.2020, 15:15

Place: The colloquium takes place online (ZOOM)

Meeting-ID: 687 6163 8786
Password: 951951

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# Integrated single molecule devices for quantum photonic technologies

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The successful development of future photonic quantum technologies will much depend on the possibility of realizing robust and scalable nanophotonic devices. These should include quantum emitters like on-demand single-photon sources and non-linear elements, provided their transition linewidth is broadened only by spontaneous emission. However, conventional strategies to on-chip integration, based on lithographic processes in semiconductors, are typically detrimental for the coherence properties of the emitter. Moreover, such approaches are difficult to scale and bear limitations in terms of geometries.

In the present contribution, we discuss an alternative platform, based on molecules that preserve near-Fourier-limited fluorescence even when embedded in polymeric photonic structures. Anthracene nanocrystals doped with dibenzoterrylene (DBT:Ac NCX) fluorescent molecules show unprecedented performances of single-photon emission [1] and are naturally suitable both to deterministic positioning and to the integration in hybrid devices [2-3].

Three-dimensional patterns are achieved by Direct Laser Writing (DLW) of commercial photoresists around self-assembled organic nanocrystals containing fluorescent molecules [4]. This method enables fast, inexpensive and scalable fabrication process, while offering unique advantages in terms of versatility and sub-micron resolution. We also show optical tuning of many molecules on chip [5]. The proposed technology will allow for competitive organic quantum devices, including integrated multi-photon interferometers, arrays of indistinguishable single-photon sources and hybrid electro-optical nanophotonic chips.

[1] S. Pazzagli, et al., ACS Nano 12, 4295-4303 (2018).
[2] K. Schaedler, et al., Nano Letters 19, (2019).
[3] P. Lombardi, et al., Adv. Quantum Technol. (2019), 1900083.
[4] M. Colautti, et al., Adv. Quantum Technologies 2000004 (2020).
[5] M. Colautti, et al., ACS Nano 14, 13584−13592 (2020)

# Revealing fine details of nano-plasmonics using monochromated electrons

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Field enhancement effects near metallic nanostructures are utilized by various applications of nanoplasmonics (e.g. sensing, photovoltaics, ...) to enhance light-matter interaction. Within the SFB 951 silver nanowires of finite length, being nearly ideal Fabry-Pérot resonators are used to study several highly relevant nanoplasmonic phenomena [1]. In this presentation I will discuss the use of electron energy-loss spectroscopy (EELS) with high spatial and spectral resolution to study localized surface plasmon resonances (SPRs) in metallic nanostructures. This technique is capable of revealing the spatial distribution of the magnitude of the electric field associated with individual SPR eigenmodes. While in terms of Eigenenergies and qualitative field distribution very good agreement can be found between electromagnetic simulations of plasmonic resonances in such systems and the experimental observation, a quantitative analysis of the experimental data is also capable of retrieving important information on the propagation of surface plasmon resonances in such systems. This allows, for example, the dispersion and damping of SPRs on silver nanowires to be reconstructed, including the effect that coating their surfaces with, e.g. silicon dioxide, has on these properties.

[1] M. Rothe, Y. Zhao, G. Kewes, Z. Kochovski, W. Sigle, P.A. van Aken, C.T. Koch, M. Ballauff, Y. Lu, and O. Benson, "Silver nanowires with optimized silica coating as versatile plasmonic resonators ", Scientific Reports 9 (2019) 3859