Influence of the protective DLC layer on organic plasmonic hybrid systems

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Organic plasmonic hybrid systems, consisting of a nanostructured metal substrate and organic nanofibers, have gained an increasing amount of attention due to their ability to generate, control and sense surface plasmon polaritons [1]. The most commonly used material for substrates in hybrid systems is gold, which is soft and therefore prone to mechanical deformations. It has been shown that the mechanical properties of the gold plasmonic substrates can be improved by applying a protective diamond-like-carbon (DLC) coating [2]. Nevertheless, the influence of the DLC layer on plasmonic hybrid systems has not been yet investigated.

In this work, we investigate plasmonic hybrid systems, consisting of 1-Cyano-quaterphenylene (CNHP4) nanofibers on top of gold nano-square arrays, covered with DLC layers of various thicknesses (25, 55, 105 nm). To confirm the field enhancement on top of the DLC layers, we compare the second harmonic response of organic nanofibers, located on plasmonic arrays, to those located on a plain gold film. Subsequently, we perform time-resolved photoluminescence measurements to verify a reverse interaction, where plasmonic coupling is considered as one of the loss channels for photoluminescence from organic nanofibers.

Our measurements reveal an optimum DLC coating thickness of 25 nm, for which the plasmonic substrate remains active. For thicker coatings (above 55 nm) we do not observe an interaction between the plasmonic substrate and the organic nanofiber. Our research explains the influence of the protective DLC layer on plasmonic hybrid systems, pointing out limitations in the coating thicknesses, which is a step-forward towards producing robust plasmonic substrates.

References:

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