Enhanced Light–Matter Interactions in Graphene-Covered Gold Nanovoid Arrays - DTU Orbit (09/11/2017)

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The combination of graphene with noble-metal nanostructures is currently being explored for strong light–graphene interactions enhanced by plasmons. We introduce a novel hybrid graphene–metal system for studying light–matter interactions with gold-void nanostructures exhibiting resonances in the visible range. Enhanced coupling of graphene to the plasmon modes of the nanovoid arrays results in significant frequency shifts of the underlying plasmon resonances, enabling 30% enhanced absolute light absorption by adding a monolayer graphene and up to 700-fold enhancement of the Raman response of the graphene. These new perspectives enable us to verify the presence of graphene on gold-void arrays, and the enhancement even allows us to accurately quantify the number of layers. Experimental observations are further supported by numerical simulations and perturbation-theory analysis. The graphene gold-void platform is beneficial for sensing of molecules and placing Rhodamine 6G (R6G) dye molecules on top of the graphene; we observe a strong enhancement of the R6G Raman fingerprints. These results pave the way toward advanced substrates for surface-enhanced Raman scattering (SERS) with potential for unambiguous single-molecule detection on the atomically well-defined layer of graphene.

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