Active plasmonic colloid-to-film-coupled cavities for tailored light−matter interactions

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For large-scale fabrication of optical circuits, tailored subwavelength structures are required to modulate the refractive index. Here, we introduce a colloid-to-film-coupled nanocavity whose refractive index can be tailored by various materials, shapes, and cavity volumes. With this colloidal nanocavity setup, the refractive index can be adjusted over a wide visible wavelength range. For many nanophotonic applications, specific values for the extinction coefficient are crucial to achieve optical loss and gain.[1] We employed bottom-up self-assembly techniques to sandwich optically active ternary metal-chalcogenides between a metallic mirror and plasmonic colloids. The spectral overlap between the cavity resonance and the broadband emitter makes it possible to study the tunable radiative properties statistically. For flat cavity geometries of silver nanocubes with sub-10 nm metallic gap, we found a fluorescence enhancement factor beyond 1000 for 100 cavities and a 112 meV Rabi splitting. In addition, we used gold spheres to extend the refractive index range. By this easily scalable colloidal nanocavity setup, gain and loss building blocks are now available, thereby leading to new generation of optical devices. [2]

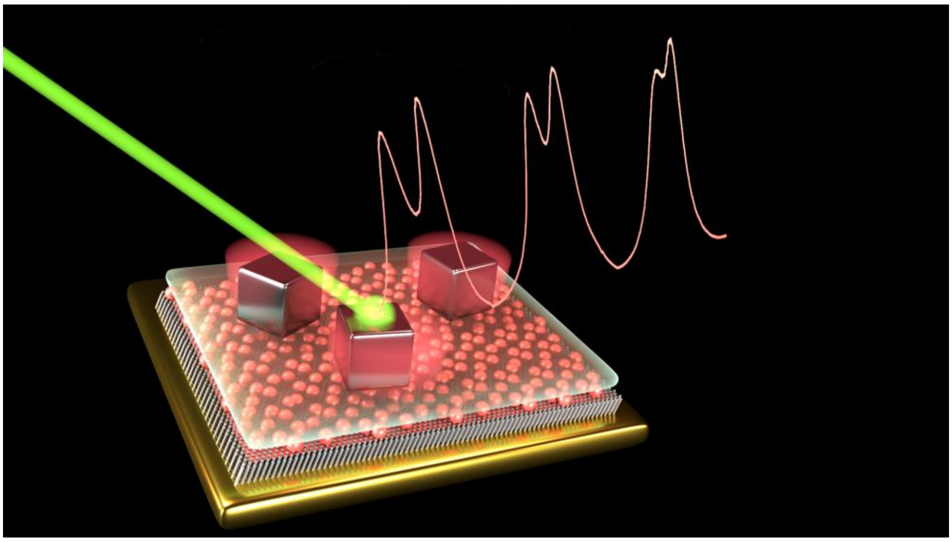

Figure 1. Schematic illustration of the coupling induced mode hybridization in silvercube-to-goldfilm geometires.

[1] Goßler, F. R.; Steiner, A. M.; Stroyuk, O.; Raevskaya, A.; König, T. A. F., Active Plasmonic Colloid-to-Film-Coupled Cavities for Tailored Light–Matter Interactions. *J. Chem. Phys. C* **2019,** *123* (11), 6745-6752.
[2] Mayer, M.; Schnepf, M. J.; König, T. A. F.; Fery, A., Colloidal Self-Assembly Concepts for Plasmonic Metasurfaces. *Adv. Opt. Mater. 0* (0), 1800564.