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Vacuum Rabi splitting of a dark plasmonic cavity mode revealed by fast electrons

Recent years have seen a growing interest in strong coupling between plasmons and excitons, as a way to generate new quantum optical testbeds and influence chemical dynamics and reactivity. Strong coupling to bright plasmonic modes has been achieved even with single quantum emitters. Dark plasmonic modes fare better in some applications due to longer lifetimes, but are difficult to probe as they are subradiant. Here, we apply electron energy loss (EEL) spectroscopy to demonstrate that a dark mode of an individual plasmonic bowtie can interact with a small number of quantum emitters, as evidenced by Rabi-split spectra. Coupling strengths of up to 85 meV place the bowtie-emitter devices at the onset of the strong coupling regime. Remarkably, the coupling occurs at the periphery of the bowtie gaps, even while the electron beam probes their centre. Our findings pave the way for using EEL spectroscopy to study exciton-plasmon interactions involving non-emissive photonic modes.

Primary author: Dr KVAPIL, Michal (Institute of Physical Engineering, Brno University of Technology, Czechia)

Co-authors: Dr BITTON, Ora (Chemical Research Support Department, Weizmann Institute of Science, Israel); Dr GUPTA, Satyendra Nath (Department of Chemical and Biological Physics, Weizmann Institute of Science, Israel); Dr HOUBEN, Lothar (Chemical Research Support Department, Weizmann Institute of Science, Israel); Dr KRÁPEK, Vlastimil (Central European Institute of Technology, Brno University of Technology, Czechia); Prof. ŠIKOLA, Tomáš (Brno University of Technology); Prof. HARAN, Gilad (Department of Chemical and Biological Physics, Weizmann Institute of Science, Israel)

Presenter: Dr KVAPIL, Michal (Institute of Physical Engineering, Brno University of Technology, Czechia)

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