Vibrational Strong Light-Matter Coupling in Microcavities Based on Reflective Germanium Coatings

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Abstract: The field of strong light-matter coupling goes back to Polaritons, first predicted by Prof. J.J. Hopfield, and atom-based Cavity QED, and then later to microcavity exciton-polaritons, and more recently to other strongly coupled states such as those based on infrared vibrational transitions in organic materials. Generally, strong light-matter coupling is achieved by situating some material inside a resonantly tuned optical microcavity wherein the interaction strength between the material and the vacuum optical field is faster than all competing dephasing processes. In mid-infrared vibrational strong coupling (VSC), the optical microcavity is usually composed of semi-transparent gold mirrors or low-loss Dielectric Bragg Reflectors (DBR's). In general, we use a combination of UV-VIS-MIR spectroscopies in order to characterize the microcavity and vibrationally active organic layer. Here we show that VSC can be achieved using thin films of Germanium for the mirror components of the microcavity device. Germanium is a unique choice for the mirrors because it possesses very high refractive index n = 4.0, low absorption loss in the mid-IR, and is readily deposited via vacuum thermal evaporation. We will cover our recently reported results of using Germanium based mirrors to form an open microcavity (OMC), wherein the resonance of the microcavity is tunable, and compare the performance of these devices to gold and DBR based OMC's. We will also discuss some intriguing possibilities of using Germanium coatings to form planar photonic-crystal architectures for achieving VSC.

Bio-Sketch: Prof. Yaakov R. Tischler is the founder and PI of the Device Spectroscopy Laboratory (DSL) at Bar-Ilan University. With over 13 years leading DSL, Yaakov has published 60 papers in refereed scientific journals, registered 14 US Patents, and supervised more than 40 students and researchers. Yaakov's scientific passion is studying light-matter interactions. His lab's expertise is in Microcavity polariton devices, Raman spectroscopy, and AFM-based near-field spectroscopy.