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VIBRATIONAL STRONG LIGHT-MATTER COUPLING USING A WAVELENGTH-TUNABLE MID-INFRARED OPEN MICROCAVITY

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An open microcavity (OMC) is an optical system that is composed of two mirrors, where one is fixed and the second is on a movable stage. OMCs enable tuning the optical resonances of the system and insertion of different materials between the mirrors and are therefore of large scientific interest due to their many potential applications. Strong light-matter coupling of the vibrational transitions of organic molecules with the optical modes of a microcavity generates new polaritonic states in the mid-infrared (mid-IR) spectral region. Here we achieve strong light-matter coupling in the mid-IR using a low optical-loss OMC that is wavelength-tunable via a piezoelectric actuator. A thin film of poly (methyl methacrylate) (PMMA) was deposited onto one of the mirrors to couple the narrow and intense absorption peak of the carbonyl stretch mode at 1731 cm-1 to the OMC. Polaritonic states are observed in FTIR transmission measurements when an OMC resonance is matched to the carbonyl stretch. By dynamically varying the cavity photon mode around the resonance condition, we determine the normal mode polariton dispersion relation and obtain a maximum Rabi-splitting $\hbar\Omega R=7.0\pm0.18$ meV. Different cavity line widths and Rabi-splittings can be achieved by changing the mirror separation, thus providing control of the coupling strength relative to dephasing. The ability to insert multiple materials inside an OMC and generate strong light-matter coupling over a large range of wavelengths can open new paths toward chemical reaction modification and energy transfer studies in the mid-IR.

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