Resonant Plasmonic and Vibrational Coupling in a Tailored Nanoantenna for Infrared Detection

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A novel resonant mechanism involving the interference of a broadband plasmon with the narrowband vibration from molecules is presented. With the use of this concept, we demonstrate experimentally the enormous enhancement of the vibrational signals from less than one attomol of molecules on individual gold nanowires, tailored to act as plasmonic nanoantennas in the infrared. By detuning the resonance via a change in the antenna length, a Fano-type behavior of the spectral signal is observed, which is clearly supported by full electrodynamical calculations. This resonant mechanism can be a new paradigm for sensitive infrared identification of molecular groups.