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**Gain-Plasmon Dynamics in Metamaterials**

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The performance of all metamaterial-based applications is significantly limited by the inherent and strong energy dissipation present in metals, especially in the visible range. We experimentally demonstrate that the incorporation of excitonic material in the high-local-field areas of plasmon nanostructures induce coherent resonant energy transfer processes from chromophores (donors) to plasmon nanoentities (acceptor). Ultra-fast fluorescent time-resolved spectroscopy paired with transient absorption spectroscopy and spectroscopic ellipsometry in pump-probe configuration emphasize a strong exciton-plasmon coupling behind the process of non-radiative excitation energy transfer (RET). Across scales studies show how these energy transfer processes occurring at the nanoscale translate to bulk materials. Multipronged strategies–bio-inspired and bottom up–allowed obtaining important advances in materials science and paves the way toward further promising scientific research aimed to enable the wide range of electromagnetic properties of optical metamaterials.