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Near-field intensity correlations in metal-dielectric nano-composites

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Spatial correlations of field and intensity are indicative of the nature of wave transport in random media and have been widely investigated in the context of electromagnetic wave propagation in disordered dielectric systems. However, less is known of near-field intensity correlations in metallic random systems, which can exhibit rich phenomena due to the involvement of intrinsic resonance effects—surface plasmons. Neither is clear the difference between correlation functions in metallic and dielectric systems. This paper presents the first experimental study of near-field intensity correlations in metal-dielectric systems in regimes where localization and delocalization are expected. Significant differences are observed between the spatial intensity correlations functions in metal-dielectric systems and those of purely dielectric random media. In disordered metallic nanostructures, surface plasmon modes are governed by the structural properties of the system and may be strongly localized. Recent theoretical studies of metallic nanoparticle aggregates suggest that the eigenmodes of such systems may have properties of both localized and delocalized states. However, it is not clear how such eigenmodes impact the propagation or localization of surface plasmon polaritons excited by impinging light, an issue addressed in this study. In the current experiment, the concentration of metal particles on a dielectric surface p was varied over a wide range to control the amount of scattering. Spatial intensity correlations obtained from near-field optical microscopy (NSOM) images show a transition from propagation to localization and back to propagation of optical excitations in planar random metal-dielectric systems with increase in metal filling fraction.