Type of presentation: Poster

ID-1-P-3094 Plasmon coupling in gold and silver nanosphere dimers probed by electrons

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Plasmon coupling in closely spaced noble metal nanoparticles, producing among other effects a shift in the localised surface plasmon resonance energy (LSPR) supported by the assembly, has led to their applications in several technological fields such as ultrasensitive biosensing and nanophotonics [1,2]. Despite rapid progress in these fields, direct imaging and characterisation of LSPRs in nanostructures remains a challenge, due to the insufficient spatial resolution of most optical techniques. Alternatively, the use of electron energy-loss spectroscopy (EELS) as a complementary method to probe the plasmonic and optical properties of nanostructures has become increasingly popular, owing to the Ångström spatial resolution of this technique. Here we have applied scanning transmission electron microscopy (STEM) imaging and EELS to study the plasmonic properties of individual nanosphere dimers as a function of interparticle distance, accessing both the classical and the quantum regimes. In particular, we accurately determine and compare the scaling of the LSPR energy with interparticle distance in gold and silver dimers [3]. This calibration is of great importance to nanometrology tools such as plasmon rulers, in which the shift in LSPR energy is used for distance measurement in biological and chemical systems [4]. Furthermore, we study dimers separated at subnanometer distances, monitoring their transition from classical to quantum systems as particles approach and merge, and from the onset of tunnelling to charge transfer between the particles, as a nano-bridge forms between them [5]. Finally we explore the possibility of combining EELS and optical spectroscopy by utilising TEM specimen holders with light input-output capabilities.

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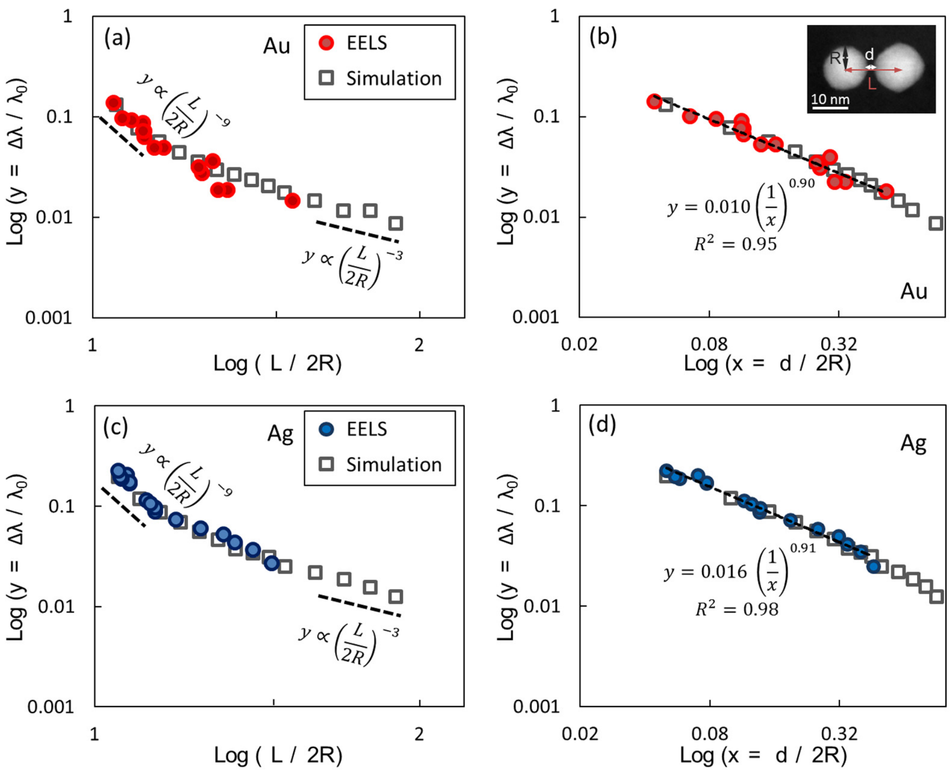

Fig. 1: The fractional LSPR wavelength shift $\Delta\lambda/\lambda_0$ in gold and silver dimers as a function of ratios (L/2R) and (d/2R), where λ and λ_0 are the LSPR wavelengths in a dimer and in a single particle, respectively, and L, d and R are defined in the inset image in (b).

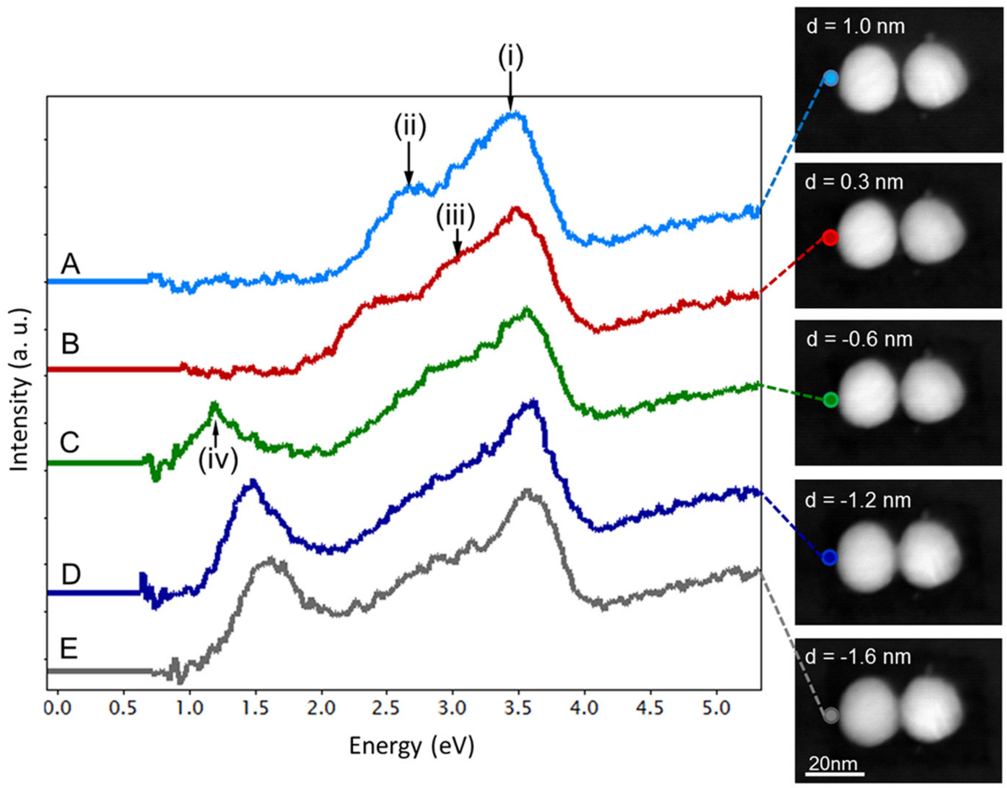

Fig. 2: STEM images and EELS spectra from a pair of silver nanoparticles with separation distances d = +1.0 to -1.6 nm, as they approach and merge, revealing the transition from classical behaviour (A) to tunnelling (B) to a contact regime (C-E).