Scattering Enhancement in a colloidal metal-organic composite

V. Villari, B. Fazio, N. Micali  
CNR-IPCF Istituto per i Processi Chimico-Fisici, V.le F. Stagno d’Alcontres 37, I-98158, Messina, Italy  
G. De Luca  
CNR-IMCB Istituto per i Materiali Compositi e Biomedici, P.le Tecchio, I-80125 Napoli, Italy  
M. Trapani, A. Romeo, L.M. Scolaro  
Dipartimento di Chimica Inorganica, Chimica Analitica e Chimica Fisica dell’Università di Messina, V.le F. Stagno d’Alcontres 31, I-98166, Messina, Italy  
M.A. Castriciano, A. Mazzaglia  
CNR-ISMN Istituto per lo Studio dei Materiali Nanostrutturati, V.le F. Stagno d’Alcontres 31, I-98166, Messina, Italy

In colloidal aggregates of metal nanoparticles composite the local electric field at some nanoparticles differs significantly from the bulk. In these sub-wavelength regions, called hot spot, the electromagnetic field can be enhanced by several order of magnitude (originating a strong Rayleigh and Raman scattering) via dipole-dipole interaction, when the frequency of the illuminating field is close to the system dipolar eigenmodes frequency [1].  
The enhancement factor of the Rayleigh scattering (defined as the ratio between the scattering from the aggregated particles and that of an equivalent number of non-interacting particles) scales with the spectral parameter (the relative frequency detuning) with exponent $d_0$, called the optical spectral dimension (the counterpart of the spectral dimension in the case of vibrational excitations), that characterizes the scaling of the dipolar density of states [2].  
We report the study of three-component hybrid organic-inorganic aqueous solutions based on gold nanoparticles (Au-NP) in the presence of spermine and porphyrin. In this system an enhancement of the Rayleigh and Raman scattered light is observed. The ternary metal-organic composite is formed when porphyrins are seeded into the substrate matrix consisting of gold nanoparticles capped with spermine [3]. The formation of the hybrid organic-inorganic nanocomposite is put in evidence by the scaling relation of the scattering enhancement. The obtained optical spectral dimension $d_0$ takes a values of 0.3, that agrees with the results from numerical simulations on DLCCA fractal aggregates of metal nanoparticles.