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Optical tracking of single Ag nanodots in nanostructured water films

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Monodisperse silver nanoparticles synthesized via Ag (I) carboxylate in zeolite Y cages are investigated on silicon dioxide (SiO_2) and mica surfaces with optical and atomic force techniques. Subnanometer particles escaping the Y cage show a strong and photostable fluorescence emission in the visible range (see Figure 1) and allow for optical single particle tracking revealing spatial diffusion of Ag particles on SiO_2 within a few nanometre thick and nanostructured water film. Heterogenous diffusion dynamics reflect the transition from an ice-like to a liquid-like water film as a function of film thickness. The contributions of the different diffusion coefficients strongly correlate both with the water film thickness and the chemical composition of the interface. The heterogeneity of the diffusion is caused by ad- and desorption of Ag particles to silanol groups at the SiO_2 interface which couple vibronically to the Ag particles as can be seen from single particle fluorescence spectra.

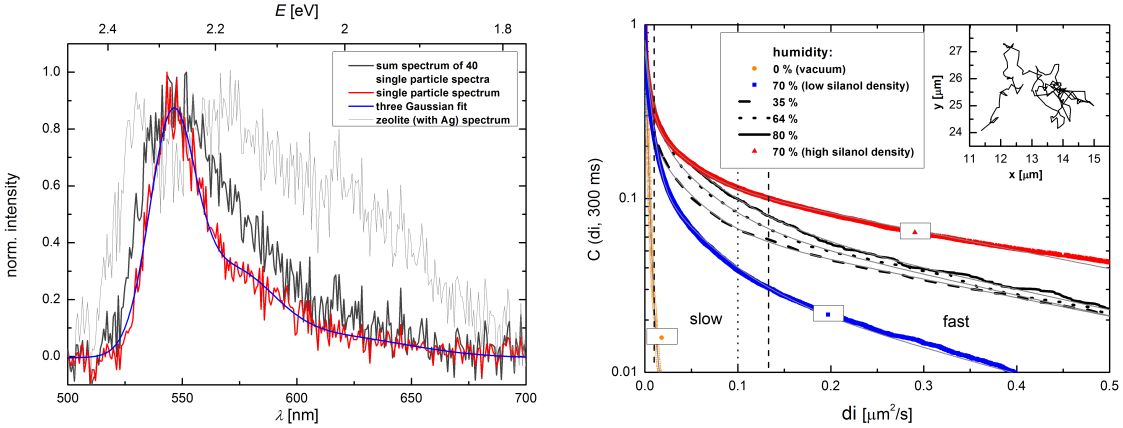

Figure 1: (left) Normalized spectrum of a single Ag nanoparticle (red data) with a three component Gaussian fit to the data (blue line) and the sum-spectrum of 40 different single particles (black line). The broad light gray line represents the spectrum taken from a zeolite particle including a variety of Ag particles with different sizes. *This spectrum is very similar to the one reported recently [1].* (right) Complementary cumulative probabilities of the diffusivities di of Ag nanoparticles on SiO_2 for four different humidities and two differently treated substrates. The curves can be roughly separated into three principle regimes as separated by the two vertical dashed lines. The first one (left) includes only very small diffusivities which in fact represent immobile particles, while the second and the third regime correspond to slow and fast diffusing particles, respectively. Each data set is fitted by three exponential functions (except the curve for 0 % relative humidity measured in vacuum). The inset shows an example trajectory.

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References

[1] J. Zheng, R.M. Dickson: *Individual water-soluble dendrimer-encapsulated silver nanodot fluorescence*. J. Am. Chem. Soc. **124**, 13982–3983 (2002)