Dynamics of a bidimensional gel around its percolation transition

D. Orsi, L.Cristofolini

Affiliation: Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Parma, Parma (IT)
davide.orsi@fis.unipr.it

The morphology, the mechanical properties and the microscopic internal dynamics of a bidimensional gel formed by spontaneous aggregation of gold nanoparticles floating on the water surface are investigated by a suite of techniques, including grazing-incidence x-ray photon correlation spectroscopy (GI-XPCS).

The evolution of the statistical properties of the structured network, as a function of the externally controlled density, is related to the corresponding evolution of the mechanical properties [1]. We identified three steps in the gel formation: a first step occurs in the incubation time, in which the individual nm-sized gold nanoparticle aggregate to form quasi 1D structures of typical length of a few microns. The second step occurs in the first stages of the compression, with the growth of the branched structure, finally yielding to the onset of the infinite percolative cluster (figure 1, left), which is related to the building of the mechanical elastic modulus. In correspondence with this evolution of the structure and mechanical response of the system, we observed an intrinsic link between the mechanical modulus and GI-XPCS fluctuations. We found a transition from diffusive-like to arrested dynamics, characterized by intermittent random rearrangement events [2].

The dynamical features observed by GI-XPCS, including dynamical heterogeneities [3], are interpreted also in view of the results of microscopical imaging in the direct space [4].

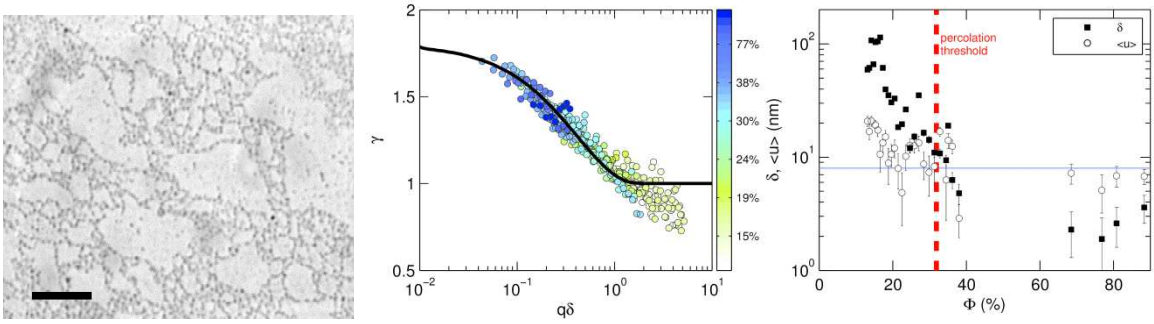

Figure 1: left: *image of the percolated nanoparticle network at surface concentration* $\Phi = 29\%$*, taken using an inverted microscope with a 50X objective (bar: 200*μ*m). Center: transition from diffusive (* $\gamma \leq 1$ *) to arrested (* $\gamma > 1.5$ *) dynamics. Right: as concentration increases, dynamics' characteristic lengths decrease to a limit value compatible with the nanoparticle's size.*

References

[1] D. Orsi, A. Vezzani, R. Burioni, A. Pucci, G. Ruggeri, and L. Cristofolini, Colloids Surfaces A Physicochem. Eng. Asp. (2013).
[2] A. Duri and L. Cipelletti, Europhys. Lett. **76**, 972 (2006).
[3] D. Orsi, L. Cristofolini, G. Baldi, and A. Madsen, Phys. Rev. Lett. **108**, 105701 (2012).
[4] D.Orsi et al. in preparation.