Hybrid networks based on the interplay of Au nano-particles and CuPcSu ligands-Electronic transport in mesoscopic scale

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We report on the fabrication and study of the electronic transport properties of planar devices based on nano-dimensional components, namely semiconducting conjugated oligomers and metal nanoparticles (NPs). Spherical gold (Au) NPs were linked by means of copper 3-diethylamino-1-propylsulphonamide sulfonic acid substituted phthalocyanine (CuPcSu) molecules to form a network confined between Au nanodistant electrodes. Fabrication of these devices was realized via three different approaches: (a) liquid phase approach: Au NPs (av. diameter 17 nm) prepared as hydrosol with chemical reduction were functionalized with CuPcSu and drop cast on the substrate, (b) self-assembling technique: The SiO_2 surface was chemically modified with a stable, positively charged template molecule (3-aminopropyl triethoxysilane, APTES)[1] and the CuPcSu surface-functionalized Au NPs were subsequently adsorbed on the surface driven by electrostatic-type forces and (c) solid state approach: Ultra-fine (av. diam. 4.5 nm) Au NPs were prepared by thermal evaporation and inter-particle gaps were filled with CuPcSu ligands in a subsequent step. The above systems were confined between Au nano-electrodes with inter-electrode distances of 25 and 50nm fabricated on $n-Si/SiO_2$ substrate via e-beam lithography. The conduction mechanisms of these 2D systems were studied using quasi-static and dynamic voltage-current measurements in the 78K-300K temperature range. It was possible to discriminate between various transport mechanisms typical for such structures (i.e. tunneling and hopping), to evaluate conduction thresholds and to reveal charging effects involving few electrons, at lower temperatures. The interpretation was assisted by AFM, FE-SEM and TEM imaging techniques. The system of evaporated NPs (case c) resulted in formation of closely-packed linked NP networks and yielded the best stability and results' reproducibility.

References

[1] Decher, G. Fuzzy, Science, **277**, 1232–1237 (1997).

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