NANOPARTICLE DISPERSIONS OF ORGANIC LUMINESCENT AND SEMICONDUCTING MATERIALS

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In the last few years research on different kinds of organic nanoparticles is steadily increasing. In the past, inorganic particles in the size range of a few nanometres were found to show size dependent optical and electronic properties. Organic nanoparticles recently were also found to show some size dependent optical and nonlinear optical properties even in a rather big size range between 100 to 200 nm. Especially polycyclic aromatic hydrocarbons are a very interesting class of materials. They show a very broad range of interesting properties like intensive colour, fluorescence, photoconductivity, semiconducting properties and a very special chemical and photochemical behaviour. Therefore, these materials are often used for pigments and dyes, fluorescent probes, etc. and they are promising materials for sensors, bioprobes and organic electronic devices like field effect transistors. The substances selected as model substances in this study, pentacene, tetracene and rubrene, are taken from this class of materials.

While there is abundant literature on the preparation and applications of inorganic semiconductor particles, reports on organic nanoparticles are relatively scarce. A frequently used process to prepare pure organic nanoparticle dispersions is the so called re-precipitation method. [1]. Here a solution of the organic material in a good solvent is added into an excess of a poor or non-solvent under vigorous stirring. The material precipitates and submicron sized particles are formed depending on temperature, concentration, stirring and other parameters. Another method, based on laser ablation of organic crystals dispersed in a liquid has recently been introduced by Tamaki [2]. Here, a coarse powder or large crystals of an organic material are dispersed in a solvent or surfactant solution by vigorous stirring. Then, intense laser light is shone into the dispersion and strikes the crystal of organic material. Above a certain laser fluence threshold material evaporates from the surface of the crystals by a laser ablation mechanism and subsequently condenses in the surrounding liquid phase to form submicron or nanometre sized particles.

We report on different methods for the preparation of stable nanoparticle dispersions of small molecule organic semiconductors. Some of them were prepared by the re-precipitation method from solution. Also the laser ablation method has been very recently applied to this type of materials [3] and results are compared with respect to dispersion and particle properties and preparation efficiency. A novel, especially efficient technique for the preparation of highly concentrated dispersions is introduced. This direct condensation method allows the preparation of stable dispersions in high amounts and concentrations by avoiding most of the disadvantages of existing techniques. The particles were characterized regarding particle size and shape, dispersion stability and optical and spectroscopic properties. Particle size was usually about 100 nm, and the dispersions showed structured absorbance bands in the visible region typical for the respective substances (see Figures 1 and 2). Rubrene and tetracene particles gave characteristic luminescence spectra. Many different film forming and structuring methods can be applied for further processing of the nanoparticle dispersions.

They were shown to be compatible with spin coating, spray coating, dip coating, electrostatic self assembly and ink-jetting techniques. Therefore, they are very well suited for the fabrication of functional devices in organic electronics and optical sensor technology.

Results as well as advantages and drawbacks of the different organic nanoparticle formation methods are compared and discussed with respect to material properties and implications for subsequent device fabrication.

References:

[1] H. Nakanishi, H. Oikawa: *Reprecipitation Method for Organic Nanocrystals*, in: H. Masuhara, H. Nakanishi, K. Sasaki (Eds.) *Single Organic Nanoparticles* (Springer, Heidelberg 2003).
[2] Tamaki Y., Asahi T., Masuhara H., Appl. Surf. Sci., **168** (2000) 85-88.
[3] Köstler S., Rudorfer A., Berghauser R., Jakopic G., Ribitsch V., Mater. Sci. Forum, **514-516** (2006) 1235-1240.

Figures:

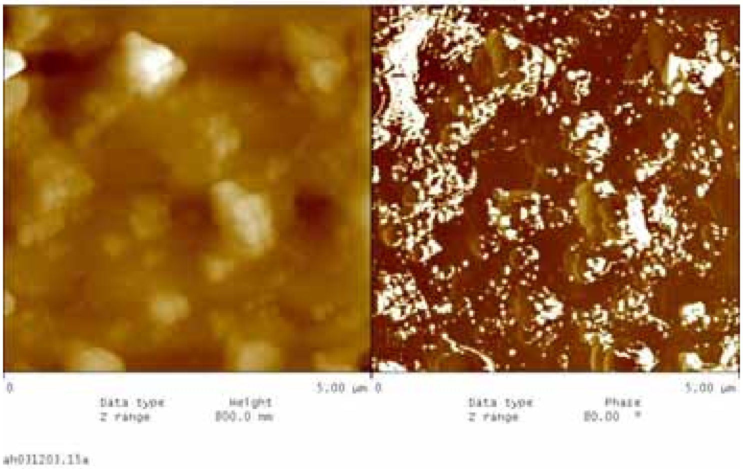

Figure 1: AFM height and phase image of pentacene nanoparticles prepared by laser ablation.

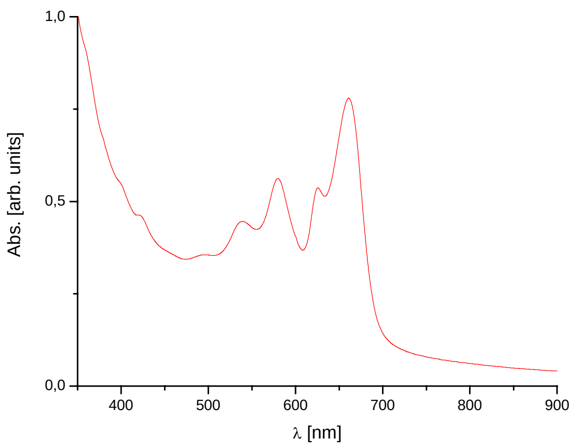

Figure 2: UV-Vis absorption spectra of a pentacene nanoparticle dispersion prepared by laser ablation.