Aerosol Synthesis of Single-walled Carbon Nanotube

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Carbon nanotubes (CNTs) are a unique family of materials exhibiting diverse useful chemical and physical properties. The CNTs and especially single-walled CNTs (SWCNTs) were found to have exceptional mechanical, thermal and electronic properties. Among different routes to synthesize SWCNTs, an aerosol CVD method is one of the most promising. This method allows growing high quality and cleaning SWCNTs with certain diameters and lengths. CNTs can be easily deposited onto practically any substrate including temperature nontolerant ones, so that time-consuming steps of CNT purification from the catalyst and support, dispersion and deposition processes are avoided. Supplementary advantages of the aerosol method are possibilities to on-line control of the CNT quality and separate individual and bundled CNTs. This continuous aerosol CVD process is one of the most promising and powerful methods for the high-yield synthesis at controlled conditions.

The presentation will review the results obtained by two different aerosol synthesis methods developed at Department of Applied Physics. In the first method, catalyst particles were produced by evaporating catalyst material from resistively heated Fe wire (a hot wire generator, HWG method) [1]. The second method is based on ferrocene vapor decomposition in carbon monoxide atmosphere [2]. We report the investigations of the formation mechanism of single-walled carbon nanotubes [3, 4] and a novel hybrid material, NanoBuds [5], SWCNTs with covalently attached fullerenes. The mechanism of charging of CNTs in the gas phase due to the bundling process is reported [6]. The integration of the CNTs produced by aerosol methods directly into final applications is discussed [7, 8]. Also we report a simple and rapid method to prepare multifunctional free-standing single-walled carbon nanotube (SCWNT) films with variable thicknesses ranging from a sub-monolayer to a few micrometres having outstanding properties for a broad range of exceptionally performing devices. We have fabricated state-of-the-art key components from the same single component multifunctional SWCNT material for several high-impact application areas: high efficiency nanoparticle filters, transparent and conductive electrodes, electrochemical sensors with extremely low detection limits, and polymer-free saturable absorbers for ultrafast femtosecond lasers (see Figure 1). Furthermore, the films are demonstrated as the main components in gas flowmeters, gas heaters and transparent thermoacoustic loudspeakers. [9]

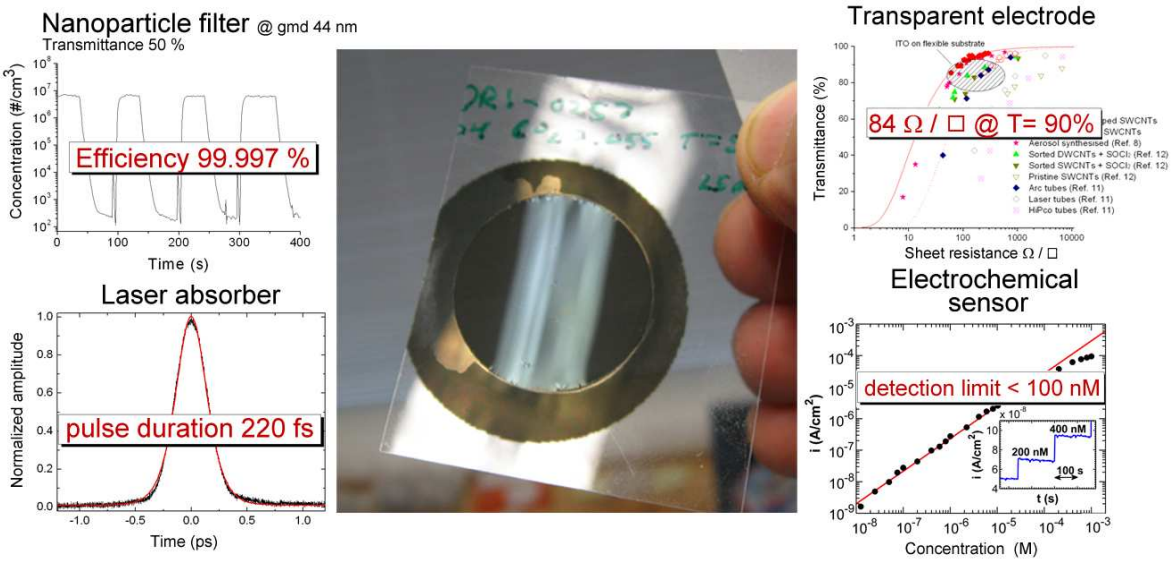

Figure 1. Multifunctional Free-Standing Single-Walled Carbon Nanotube Film.

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