Aerosol synthesis of single-walled carbon nanotubes

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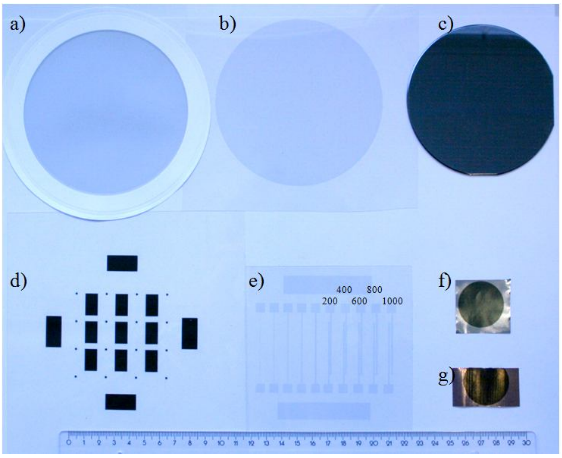
The research in the field of carbon nanotubes (CNTs) concerning their discovery, intriguing properties and applications will be briefly reviewed. Special attention will be devoted to the aerosol CVD methods and their advantages in the production of CNTs with controlled properties. The paper briefly discusses literature data in the field of aerosol synthesis and mainly focuses on the achievements obtained by our group.

Recently, we have developed two techniques for the production of high purity SWNTs: based on ferrocene vapor decomposition [1] and evaporation of iron from resistively heated catalyst wire (Hot Wire Generator - HWG method) [2]. These methods allowed us to selectively produce high quality and purity single-walled CNTs. It was shown the possibility to vary the parameters of the produced single-walled CNTs: length from 50 m to tens of micrometers and diameters of in the range from 1.1 to 2.2 nm.

Both of these methods allowed us to discover and investigate the properties of a novel material, nanobuds, consisting of fullerenes covalently attached to SWNTs [3].

Moreover, we discovered the phenomenon of spontaneous charging of SWNTs and thoroughly investigated the mechanisms of SWNT charging [4,5]. This allowed us to develop a method for gas-phase separation of individual SWNTs with their subsequent deposition onto a variety of substrates[6], alternative methods to time-consuming liquid separation method.

Recently, we demonstrated an aerosol CVD process to dry-deposit large area SWCNT-networks with tuneable conductivity and optical transmittance on wide range of substrates including flexible polymers [7]. These SWCNT-networks can be chemically doped to reach sheet resistance as low as 110 Ω/□ at 90 % optical transmittance. Wide application potential of these networks is demonstrated by fabricating SWCNT-network based devices such as a transparent capacitive touch sensor, thin-film transistors (TFTs) and bright organic light emitting diodes (OLEDs).



A photograph of various substrates with dry transferred SWCNT-networks: a) a filter covered by SWCNTs after filtering the flow at the outlet of the reactor; b) SWCNT-network film on PET; c) a silicon wafer fully covered by SWCNT-network; d) and e) SWCNT-networks patterned using masks under the filter and transferred to PET. The number shows the distance between electrodes in μm. SWCNT-network on f) Fe and g) Cu foils.

SWNTs produced by this method were successfully applied to memory devices[8], field effect transistors [9] and cold electron field emitters[10].

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