

Growing carbon nano tubes with a simple CVD process on predefined patterns of Pd nano particles that where positioned to charge patterns created with a scanning electron microscope.

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We are developing a new technique for directed deposition of charged nano particles suspended in a gas on insulating substrates. We use a glowing wire generator (GWG) in combination with a differential mobility analyzer (DMA) as the source of charged nano particles and a scanning electron microscope (SEM) for writing charge patterns. This new technique can be used for directing nano particles with sub micron precision on arbitrary patterns on a macroscopic scale. This may have a wide range of applications in industry and research, such as catalyst particles for self-grown nano structures on specified positions, reaction species in micro bio-sensors, lab on a chip applications etc.

In this paper we will present the experimental setup and experiments of directed deposition of charged nano particles on negative charge patterns created with a SEM and the growth of carbon nano tube on the positions where the nano particles were positioned. In fig.1 a schematic drawing of the experimental setup is given. The SEM is a state of the art environmental field emission SEM (Fei 200 FEG Quanta) that is modified in such a way that it can be used as a pattern generator for writing charged patterns on insulators. To overcome discharging of the patterns in air a loadlock is connected to the SEM such that the substrate can be transferred to the deposition chamber without breaking the vacuum. In the deposition chamber nano particles of one size and polarity are deposited onto the substrate on the created charge patterns.

The GWG is a hot glowing wire where charged nano particles are generated which are transported by a high flow of argon gas to the DMA. The DMA is used to select the right polarity and size (1-100nm diameter) of the created nano particles. After selection the particles go to the deposition chamber. The AEM is an aerosol electro meter used to count the number of charged nano particles [1,2].

The experimental procedure is as followed. An insulating substrate is placed in the SEM where a pattern of charge is written by the e-beam. After the writing process the substrate is moved to the deposition chamber. The deposition chamber is then first flushed with argon gas without suspended nano particles before letting in the argon gas with suspended mono disperse nano particles. The deposition process takes approximately 1 h. With this technique we were able to create lines of sub 100 nm width of Pd nano particles [3]. Afterwards the sample is put in a CVD oven where cnt's are grown with the Pd nano particles as catalyst. Growth conditions are: ambient pressure and a gas mixture of H₂/CH₄/C₂H₄ (20:7:6 nl/min), growth time is 4 min and cool down in H₂.

The first growth results are shown in fig. 2 where it is seen that cnt's have grown only on the positions where we Pd nano particles were deposited.

[1] C.Peineke, M.B. Attoui and A.Schmidt-Ott. J. Aerosol. Sci. 37 1651 (2006)

[2] C.Peineke and A.Schmidt-Ott. J. Aerosol. Sci. 39, 244 (2008)

[3] A.C. Zonneville, C.W. Hagen, P. Kruit and A. Schmidt-Ott. Micro Electronic engineering 2008 in press.

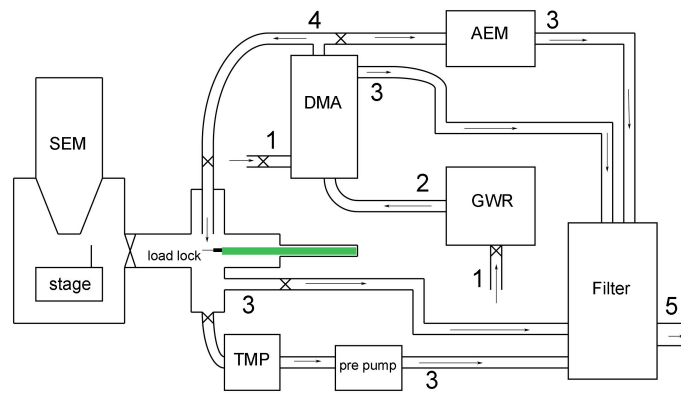


Fig. 1; Experimental setup; 1 gas flow in, 2 polydisperse particles out, 3 flow to filter, 4 mono disperse particles to deposition chamber, 5 flow to exhaust. DMA= differential mobility analyzer, AEM= aerosol electro meter, GWR= glowing wire generator and TMP= turbo molecular pump.

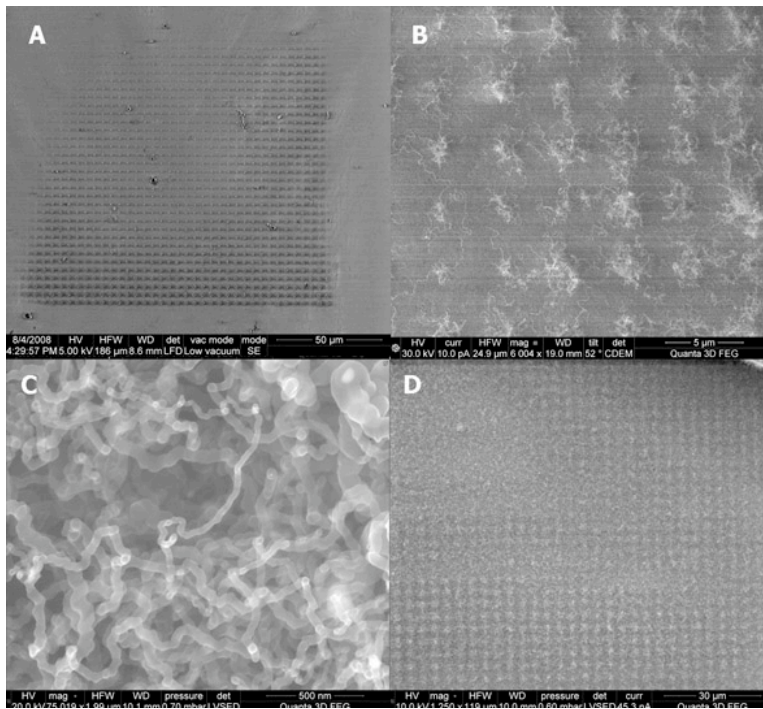


Fig. 2; A: Pd nano particles deposited in a regular array on Si_3N_4 , before cvd process. B: After cvd, cnt's have only grown on positions where Pd nano particles where present. C: Zoom in on grown cnt's, catalyst Pd nano particles can be seen in the grown cnt's. D: Another array of grown cnt's with Pd nano particles.