AMTC Letters
Vol. 1 (2008)

Deposition migration and coalescence of silver nanoparticles on carbon surfaces. Comparison between bent graphite and carbon nanotubes from multi microscopy investigation.

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The diffusion and coalescence of metal nanoparticles on surfaces play important roles in the dynamics of growth process of nanostructures. The influence of surface preparation is one of the key parameter in the dynamics of the migration and the anchorage of the nanoparticles on the surfaces. Among the surfaces, Carbon is the prototype element that forms extensive 2D structures that thus can be bent, pleated and furled. Due to the pliability of the building block, nature has an exceptional liberty in forming 3D structures by graphitic layers. Beside graphite, there are the classes of Carbon nanotubes that are promising material for electronic devices.

We succeeded in the deposition of silver nanoparticles with a mean diameter of 3nm ± 0.5nm on graphite terraces, pleated graphite surfaces Fig1, and multiwalled carbon nanotubes prealably depositd on HOPG. The purpose of our paper is to compare the silver nanoparticle interaction with these three kinds of carbon surfaces through the result of their diffusion on the substrates. The resulting patterns are interpreted by model calculations based on diffusion-limited aggregation with specific constraints to describe the surface curvatures and defects.

The free silver nanoparticles are formed from gas aggregation source [1]. They are mass analysed by a time of flight spectrometer before their deposition on the substrate. We ananlyse the islands resulting from the silver nanoparticle deposition by TEM, scanning electron microscopy (STM) and non contact atomic force microscopy (AFM). The deposition of the silver nanoparticles on graphite terraces lead to fractal islands isotropically distributed due to the diffusion-limited aggregation of the nanoparticles on a surface with a small number of defects ($10^{8}/cm^2$) [2]. At low flux deposition, only the graphite defects are decorated by the fractal islands in aggreement with an heterogeneous nucleation. At higher flux deposition homogeneous nucleation takes place that increases the density of islands. The deposition on pleated graphite reveals intersting behavior. It show evidence of a strong anisotropy in the nanoparticle diffusion [3]. Concave bends in the graphite surfaces can act as linear guides that collect nanoparticles from the surrounding areas. The trapped nanopartcles aggregate linearly along the bend forming a quasi one dimentional rod Fig 2. By contrast, deposition of silver nanoparticles on MWCNT's leads to a large density of islands ($10^{11}/cm^2$) that is drastically different than the deposition on pleated graphite with similar curvature. It can be interpreted as a high defect density in carbon nanotubes which are used to anchor the silver nanoparticlesFig 3.

In summary, our results on silver nanoparticle diffusion on bent graphite and/or MWCNT show very different behaviors. Although bent graphite surfaces with a little number of point defects can be used as guides for nanoparticle diffusion and anisotropic growth, MWCNT's can be used to anchor the particles.

References

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[2] C. Bréchignac et al.. Phys. Rev. Lett. **88** (2002) 196103 .
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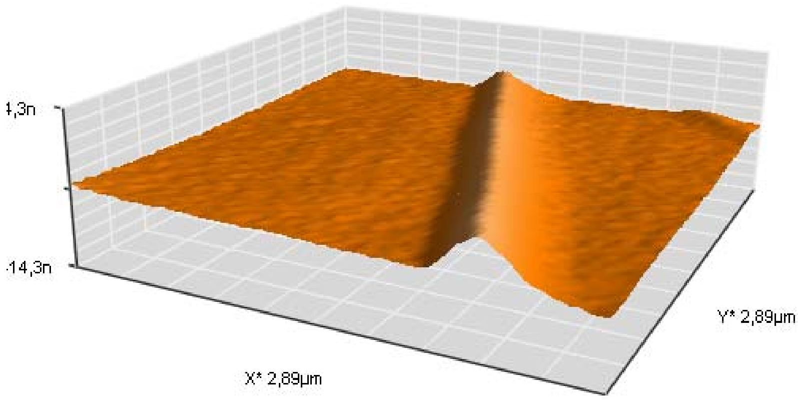

Fig 1 AFM image of pleated graphite

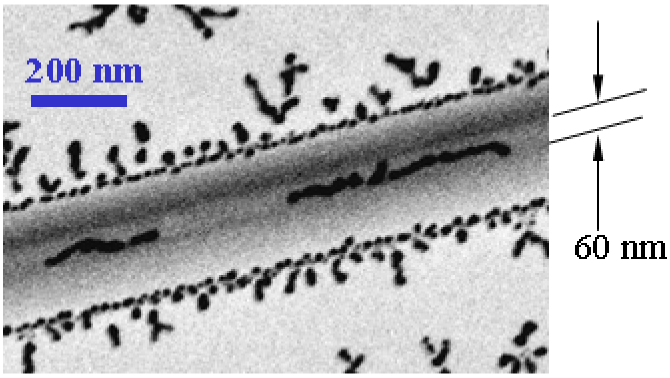

Fig 2 TEM image: The deposition of silver nanoparticles on pleated graphite are forced to grow linearly in nanorods

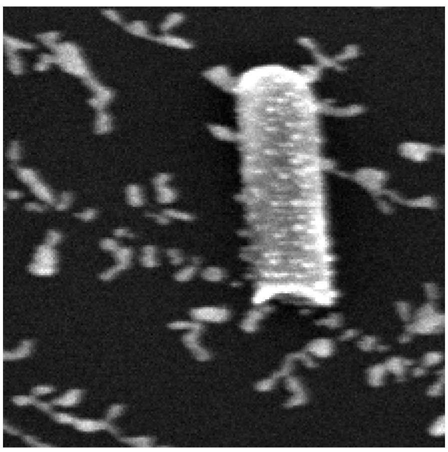

Fig 3 The deposition of silver nanoparticles on a MWCNT is used to anchor the