FORMATION OF NANOWIRES BY SELF-ASSEMBLY ON HIGHLY ORIENTED PYROLYTIC GRAPHITE (HOPG)

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Electrodeposition on Highly Oriented Pyrolytic Graphite (HOPG) steps has been proven to be an easy method for the preparation of metal (Pd, Cu, Ag etc) and metal oxide or sulfide (MoO_2, MnO_2, MoS_2) nanowires in recent years (1). These wires can be transferred on to other insulating substrates like polymers (eg, PDMS) and epoxy or cyano acrylate glues, to be used as sensors, for example palladium for the detection of hydrogen (2). The main problem during their conductivity measurements is to make macroscopic contacts to these wires. Normally, silver paints are used to form contact between transferred wires, which however provides only poor control of size and reproducibility. In order to improve this, we attempt to connect the wires, by evaporating micro pads of 200-300 nm thick film of Al and 200- 400 nm thick Au through a nano stencil.

The stencil used in these experiments is made of a 200 nm SiN membrane with apertures ranging from 250 nm to hundreds of micrometers. We studied several implementations of the micro-nano fabrication techniques such as follows: The structures were deposited on bare HOPG surface (before nanowire formation) [Figure 1], HOPG surface after nano wire formation [Figure 2], and on glass wafer spin coated with PDMS. We also evaporated metal contacts over nanowires, which were transferred from HOPG to PDMS coated glass. Wires used in these experiments have average diameters of 50-60 nm.

The distance between the sample and stencil plays a key role in the sharpness of the structures formed by shadow evaporation. The current limitation during the deposition of micro pads through stencil is the spreading of metal at the sides of the structures. This was most pronounced on graphite surface after nanowire formation and on PDMS surface with wires. This may be because after deposition of wires, the surface becomes rougher and is no more flat as bare HOPG or spin coated PDMS, so that this prevents close enough contact between substrate and stencil. The distance between sample and the stencil is kept as small as possible- in the micrometer range- to avoid spreading of the deposited structures. When stencil evaporation of 200 nm thick Au was done over wires transferred to PDMS, cracks in the gold film were observed on the polymer. This could be a result of the expansion and further contraction of PDMS during thermal evaporation and/or mechanical manipulation.

In the presentation, we will show details of microelectrode formation on HOPG using the nanostencil and nanowire formation by electrochemical method.

References:

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Figures:

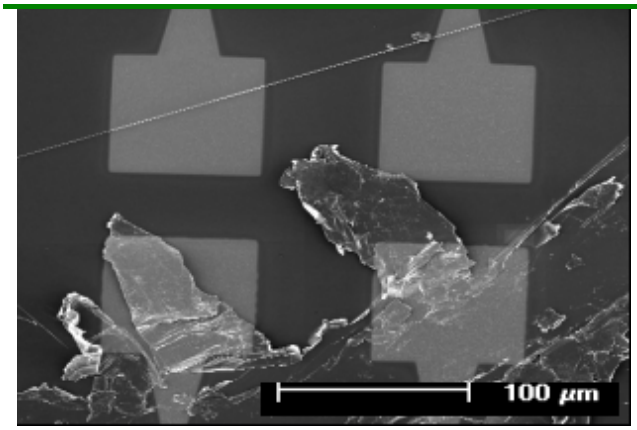

Figure 1: SEM image of bare HOPG surface after deposition of 300 nm Al through stencil.

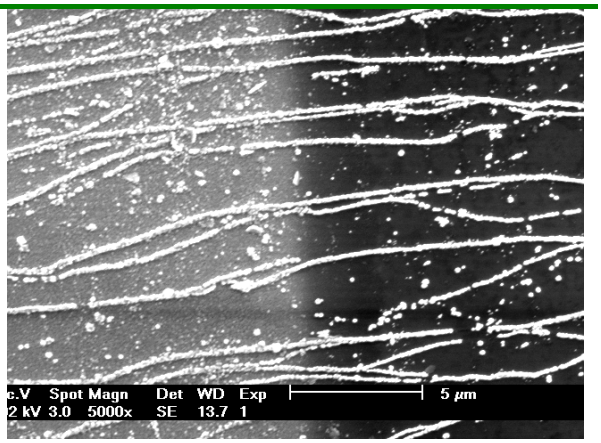

Figure 2: SEM image of bare HOPG surface with electrodeposited Palladium (60 nm) nanowires after deposition of 200 nm Al by thermal evaporation using the stencil.