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Characterization of CVD Graphene Films on Ni Substrate by EBSD and Low-kV EDS

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Graphene is the hexagonal arrangement of carbon atoms forming a one-atom thick planar sheet. Graphene has outstanding properties which render it another materials option for electronics applications [1-3]. For present work, we used ambient-pressure CVD to synthesize single- to few layer graphene films on evaporated polycrystalline Ni [4]. Because of the use of ambient pressure and readily available Ni films, this process enables the inexpensive and high-throughput growth of graphene over large areas with properties closer to those found by microcleaving highly oriented pyrolytic graphite (HOPG). Additionally, our method allows the flexibility of transferring the produced film to alternative substrates by wet-etching the Ni film. The graphene films can then be used without further treatment and exhibit outstanding properties in terms of optical transparency and electrical conductivity.

During the CVD process we exposed a polycrystalline Ni film (at 900-1000°C) to a highly diluted hydrocarbon flow under ambient pressure. This results in a deposition of an ultrathin graphene film (1 to 10 layers) over the Ni surface. The Ni films were e-beam evaporated onto SiO2/Si substrates and thermally annealed before the CVD synthesis, which produces a Ni film microstructure with single-crystalline grains of sizes between 1μm to 20 μm. During the exposure of the Ni surface to a H_2 and CH_4 gas mixture in atmospheric conditions, the Ni film and the carbon atoms provided by this CVD process form a solid solution. Since the solubility of carbon in Ni is temperature-dependent, carbon atoms precipitate as a graphene layer on the Ni surface upon cooling of the sample (Figure 1 shows images of the resulting graphene film on Ni using various SEM detectors).

In this paper we focused on characterization of the underlying structure of the Ni film in order to correlate how the structure of the Ni film (grain orientation, grain boundaries, etc) affects the resulting graphene film (example of EBSD map shown in Figure 2). We will also present data showing multi-layer graphene film distribution via low kV EDS (Figure 3).

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[5] The authors would like to acknowledge Dr. Jakub Kedzierski and Dr. Paul Healy from MIT, Lincoln Labs for providing the substrates.

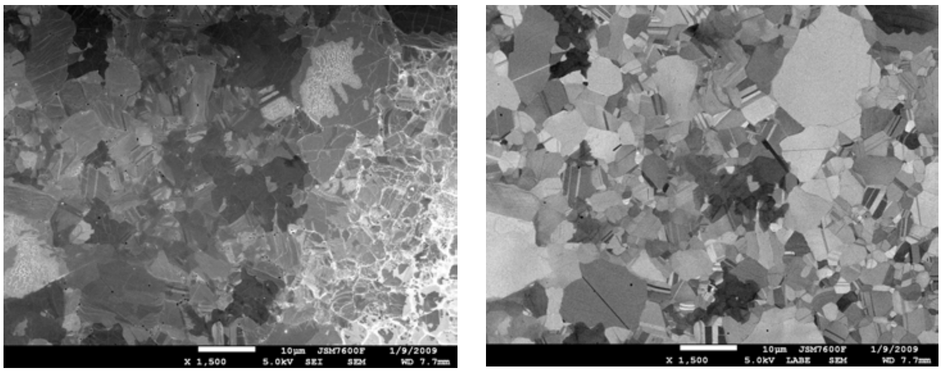

Figure 1. SEI image using in-lens detector showing graphene film coverage (left). Corresponding BEI image of the same area showing Ni film grain structure (right).

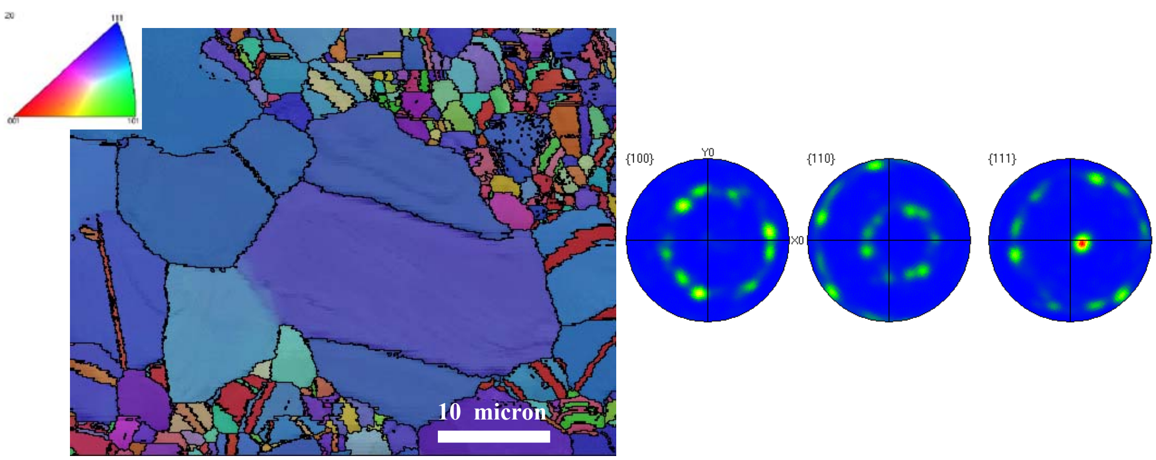

Figure 2. Left - EBSD IPF (Inverse pole figures coloring) map of Ni substrate. Right – pole figures showing distinct preferred orientation.

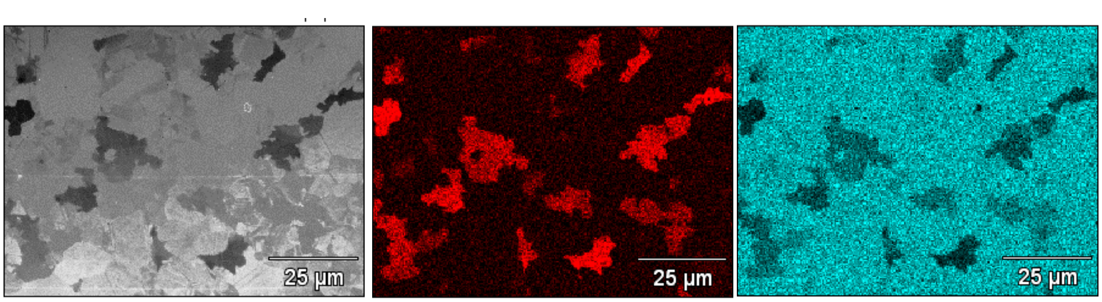

Figure 3. 2 kV EDS maps of the graphene film: C K (red) and Ni L (blue).

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