

XRD study of ultra-thin metallic films in graphene based materials for optical sensing and imaging

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We have studied the structure and crystalline orientation of Ru and Cu films grown by dc magnetron sputtering as a function of the thickness, the substrate (amorphous fused silica and crystalline sapphire (001)) and the growth temperature of the films. We have also evaluated the effect of the growth of graphene on the Ru or Cu structure and morphology. We obtained low angle and high angle diffraction patterns in θ - 2θ configuration (chi-gamma) to check the periodicity out of plane, perpendicular to the substrate and the rocking curves of the obtained peaks. To evaluate the in-plane orientation of the metallic grains we performed grazing incidence delta scans combined with theta rotation of the samples. We present here some of the results. We are still analysing the data.

1- Ruthenium films with and without graphene

The 50 nm (nominal) Ru films with graphene grown by CVD are totally oriented (001) on sapphire substrates while the films with 5 nm thickness are no more continuous and contain a small fraction of polycrystalline Ru (Figure 1). In this later case multilayer-graphene is obtained. Single layer graphene is formed for 1000°C synthesis temperature.

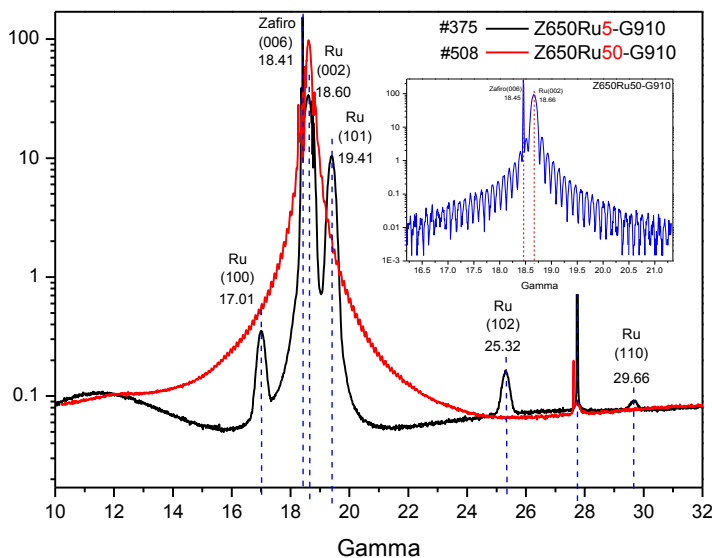


Figure 1. XRD for Graphene/Ru/Sapphire for Ru thickness of 5 nm and 50 nm. The inset shows the interferences fringes related to the film thickness (39 nm) and reveal the extreme crystalline quality of the films

We compared the diffraction patterns of Ru(5nm)/Sapphire with graphene grown at 1000 °C with an equivalent film submitted to the same annealing treatment but without methane, therefore without graphene, finding that graphene modifies the lattice parameters of the Ru film and inhibits the formation of the polycrystalline fraction.

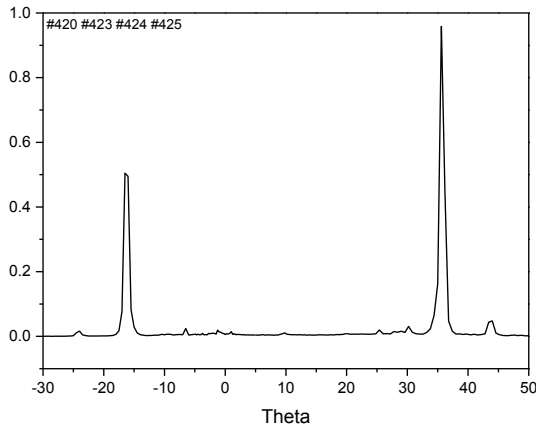


Figure 2. Theta scan in grazing incidence and delta at the (101) diffraction peak of Graphene/Ru(5nm)/Sapphire. The

The delta scans and theta scans in grazing incidence (as that shown in figure 2) allow us to study the in-plane orientation and lattice parameters of the Ru films. Clearly Ru is also almost totally oriented also in-plane, parallel to the substrate surface.

2- Cu on different substrates with and without graphene

We obtained the diffraction patterns of 500 nm copper films deposited by magnetron sputtering on fused silica, sapphire and MgO. The copper films are found to be almost totally oriented in the (100) direction for MgO and (111) for sapphire substrate while when deposited on fused silica the copper films are only slightly textured. The formation and structure of copper oxide were obtained for these thin films with controlled crystalline orientation

The data are being analyzed but the complexity of the problem requires further experiments and investigations.