Self-organized formation of different nanostructure in carbon-metal films by reactive magnetron sputtering

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Metal-containing carbon-based films (Me-C films) have been attracted much attention because metal-dopping can effectively improve and regulate film's properties (such as reducing the internal stresses, enhancing the adhesion to the substrate and improving environmental sensitivity of tribology). It has been wildly reported that various metals have been introduced into carbon-based films by different groups. However, it will bring wide differences in precisely controlling microstructure and interaction mechanism etc. aspects to metallic dopping carbon-based films due to diverse metallic elemental, prepared methods and conditions.

This report highlights a peculiar phenomenon that spontaneous formation of various nanostructure in the carbon-based films during co-deposition of different metallic element process. Consideration of different interaction between metal and carbon, we choice copper, titanium, and nickel as three typically dopping metals. The influence of various metallic elements on self-organizing special nanostructure in carbon-metal films is systematically studied. For copper, it is noncarbide and immiscible with carbon, self-organized nano-multilayered structure can be formed in the copper-carbon film when the copper concentration maintaining at 20%-40% at.% (Fig1); Titanium are strong carbide former, the nanocomposite structure of titanium carbide nanocrystalline dissolved in the amorphous carbon matrix is observed in the titanium-carbon film (Fig2); Nickel possess the ability to catalysis the growth of carbon nanowires, and self-organized carbon nano-wires structure in nickel-carbon film has been successfully prepared (Fig3), the field-emission tests of this self-assembled carbon nanowires structured film shows excellent behaviors.

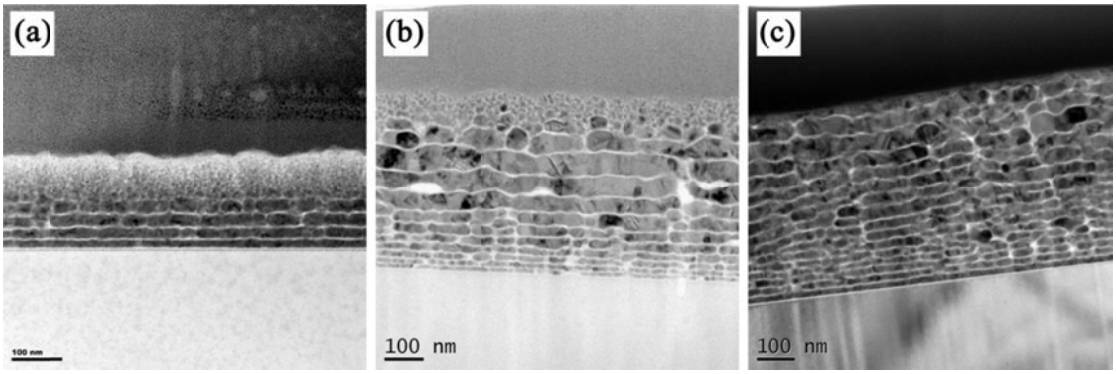

Fig1. Cross-section TEM micrographs of carbon-Cu films deposited at various deposition pressures: (a) 1.2 Pa, (b) 0.7 Pa and (c) 0.4 Pa respectively.

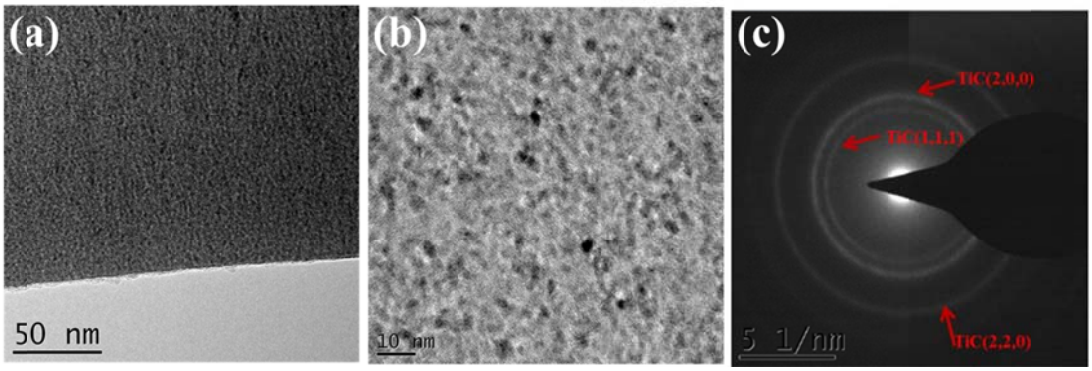

Fig2. Cross-section TEM micrographs of carbon-Ti films deposited at methane concentration of 20%, (b) and (c) show its high resolution morphology and selected area diffraction pattern respectively.

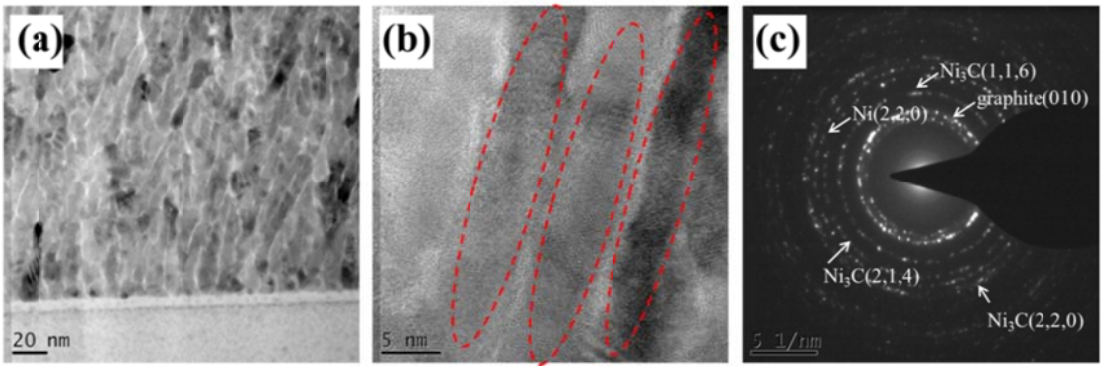

Fig3. Cross-section TEM micrographs of carbon-Nifilms deposited at methane concentration of 20%, (b) and (c) show its high resolution morphology and selected area diffraction pattern respectively.