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전기분해 DLC 합성

이상헌,최용
선문대학교 전자공학부,선문대학교 전자재료공학과

Fabrication of DLC Using Electrodeposition

Sang Heon Lee, Yong Choi
Department of Electronic Engineering, Sun Moon University, Department of Electromaterials Enginering, Sun Moon University

Abstract - Electro-deposition of carbon film on silicon substrate in methanol solution was carried out with various current density, solution temperature and electrode spacing between anode and cathode. The carbon films with smooth surface morphology and high electrical resistance were formed when the distance between electrode was relatively wider. The electrical resistance of the carbon films were independent of both current density and solution temperature.

1. 서 론

Diamond like carbon (DLC) films have attractive attentions for their properties such as high temperature semiconductivity and chemical stability[1]. Several techniques to deposit DLC films have been developedlike pulsed laser deposition, ion beam deposition, vapor deposition [2,3]. Experiment shows that the deposition from the vapor phase can be also prepared in liquid phase and vice versa [4]. Recently, Suzuki et al[5]. successfully deposited carbon films by electrolysis of a water ethylene glycol solution. The carbon film analyzed Raman spectroscopy was graphite carbon. Engineering point of view, the ethylene glycol solution is so viscous and harmful that it has a problem to clean substrate after deposition.Hence, the objectives of this study is to prepare DLC in methanol solution and characterize the final deposited film.

2. 실험방법

Analytically pure methanol (99.5%) was used as electrolyte. A silicon (100) substrate with a size of 15 × 20 × 0.3mm^3 was mounted on the negative electrode. Before deposition the substrate was in the mixture of dilute HNO3-HF solution for a few minutes and cleaned by ultrasonic treatment. The initial distance between the substrate and positive electrode was set to 10mm. The potential applied to the substrate was controlled from 0 to 5000 V under a constant temperature. Electric resistivity and surface morphology of deposited films were determined by four point probe method and scanning electron microscopy respectively.

3. 결과 및 고찰

Carbon filmsless than 2000Å thick was fabricated by electro-deposition in methanol liquid. The carbon quality formed by electro-deposition influenced by process parameters likeapplied voltage, current density, distance between electrodes and solution temperature. D.C. voltage change at a constant current density of 30mA/cm^2 with distance between Si and graphite electrode. As shown in Fig.2, the resistance of the carbon film more than 20 MΩ was observed at each electrode distance such as 3, 10, 15 and 20 mm, respectively. Low resistance of the carbon film, marked L in figure, was observed at the electrode distance of 5 mm. Since the current density was kept constant during the measurement of resistance, the voltage showed be increased with deposition time. For example, low resistance with 5 mm electrode distance shows moderate increasing of the voltage, whereas, high resistance with different electrode distance like 3, 10, 15 and 20 mm shows steep increasing of the voltage. The moderate increasing of the voltage means that the final carbon film has low resistance. The high increasing of the resistance is resulted to the dopants in the carbon film with high resistance on the silicon substrate. It is clear that its voltage change during electro-deposition can be as one of the parameters to evaluate the final deposit. Fig.3 is the resistance change with current density and solution temperature at a constant electrode distance. Solid and open circles in the Fig.3 are carbon film with high and low resistances, respectively. As the electrode of distance became wider from 10 to 20 mm, the carbon film with high resistance was tended to be formed. Especially, the carbon film with high resistance was well formed at the range of current density of 20~ 40 mA/cm2 and the temperature of 30~ 50℃. The surface of the carbon film is usually smoother than that of diamond film. The smoothness is one of important factors for the application of electronic device since the smoothness influences the effect of electric field emission, it is important to enhance the smoothness of the electronic field emitter. The surface roughness was decreased with increasing electrode distance from 10 to 20 mm. As shown in Fig.5 and 6, the smooth surface was also observed at constant current density of 30~ 40mA/cm^2. This means that the surface roughness was increased with decreasing electrode distance, resultantly,the carbon film with low resistance was formed. However, the surface roughness was decreased with increasing electrode distance, resultantly,the carbon film with high resistance was formed. A narrow electrode distance less than micro scale with high current density made electric spark so that it increases the solution temperature. The high solution temperature by the electric spark changes the electro-deposition condition which results in decreasing surface smoothness and forming the carbon film with low resistance.

4. 결 론

Carbon films were electro-deposited on Si substrates in methanol solution. The carbon films with high electrical resistance and smooth surface were formed when the distance between the electrodes was relatively wider. Surface roughness was decreased with increasing electrode distance, which tended to form the carbon film with high resistance. The electrical resistance of the films was independent of both current density and methanol liquid temperature.

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