RAMAN SCATTERING OF AMORPHOUS CN THIN FILM GROWN USING ARC PLASMA

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**Abstract**: Amorphous CN thin film has been grown in the vacuum system using arc discharge. The morphology study of the film indicates a smooth surface, which was confirmed by examination of thin film interference pattern. The Raman spectra of film show three main scattering bands and several weak bands. Experimental data indicate that the carbon and nitrogen atoms in the film were in various bonding states and the structure of the film is amorphous. The spectral patterns of thin films grown at different places away from the plasma source are almost remained unchanged. This indicates that arc discharge is one of the possible methods to prepare the uniform CN thin film.

The field of fabrication of nanoscale N-C thin film has greatly been developed recently. V. V. Uglov et al [1] studied the effect of plasma immersion N and N-C implantation at elevated temperatures (380°C and 500°C) on tool steel. P. Bugaev et al [2] investigated highly adhesive amorphous carbon films. More recently, L. H. Li [3] grown and characterized diamond-like carbon (DLC) film on aluminum.

Based on many previous results, Nanoscale C-N thin film has been grown in our laboratory. Thin films were grown by using an a.c. arcing discharge plasma source. The gap between two carbon robes connected to electrodes is 2mm. Maximum of discharge current is 3A and maximal voltage of power supply is 100V. Two pieces of permanence magnetic discs have been used to place two sides of arc discharge plasma on Z-axis.

Fig. 1 shows a typical UV resonance Raman spectrum of the film deposited on glass. The assignment of the vibration modes films is mainly based on previous results together with atomic sp structures. The Raman spectra of film show three main scattering bands. In general, $CH_x$ and $NH_x$ groups give rise to stretching vibrations at 3000 and 3300 $cm^{-1}$, respectively [4]. The 2335 $cm^{-1}$ band was due to $CO_2$ stretching [5]; $CO_2$ may originate from contamination by the environment. The band at peak 1100 $cm^{-1}$ may be attributed to T model, which previously attribute to a surface phonon model [6] but now it is identified as T model, associated with the vibrational mode of sp3-bond carbon. In general, the peak position of T band increases from 1095 to 1300 $cm^{-1}$ with the increasing of N content. This is in agreement with the previous results [7]. However, we are not able to identify a broad band at peak of 550$cm^{-1}$. After searching previous data, we tentatively assign it as carbon alloy. The reason is Raman spectrum of carbon alloy generally appears in the low frequency region, which were associated with transverse acoustic and transverse optic metal-carbon modes [8]. More detailed experiments and analyses are needed for explanation of this band.

Fig.2 shows a comparison of Raman scattering from different area of the nanoscale thin film. One is obtained close to the centre of film and other one is from the edge of the film. The spectral patterns are almost remained unchanged, indicating that the distribution of the various components is very uniform. However, the thickness of the film may vary at the different area, which result in spectral intensities variations of Raman scattering.

Fig.3 shows the morphologies of the films obtained by using scanning electron microscopy (SEM with 30kV). The result indicates a great uniform surface. Relatively, the picture obtained from the edge 5mm away from the center is little bit worse. A number of blocks with various sizes distributed in different regions were observed. The probable reason for two different surfaces at the center and edge area is that sample holder close to the edge of the sample may be sputtered by the plasma. This explanation is in agreement with the Raman spectrum for carbon alloy. The smooth of the surface can also be examined by using interference pattern.

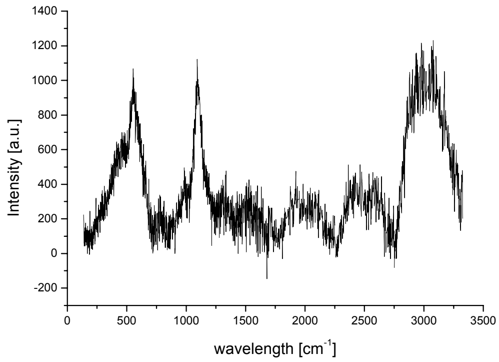


Fig. 1 shows a typical UV resonance Raman spectrum of the thin film deposited on the glass

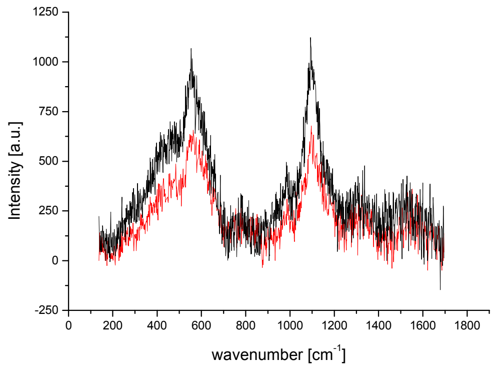


Fig.2 Raman spectral obtained from different areas of the thin film

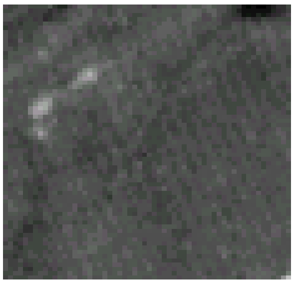

Fig.3 the morphology of the thin film deposited on glass (size: 20×20μm2 )

Fig.4 Blue light Newton interference pattern of the thin film

Fig.4 shows interference pattern (for light wavelength 416 nm) of the sample, which further confirms a quite smooth surface of the thin film we obtained even if the film is grown without using magnetic filter. The distance between two rings is 2.5mm. Based on a wedge interference model, the angle of the wedge is obtained of $4.16\times10^{-5}$ where index of this film is assumed to be 2. Correspondingly, the thickness of the thin film at the center is around 260nm.


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**References:**


1. V. V. Uglov, V. M. Anishchik, A. K. Kuleshov, J. A. Fedotova, N. T. Kvasov, A. L. Danilyuk, R. Guenzel, H. Reuther and E. Richter, Surface and Coatings Technology, **142**, 406(2001)
2. S. P. Bugaev, K. V. Oskomov and N. S. Sochugov, Surface and Coatings Technology, **156**, 311(2002).
3. R. Rajkumer, Mukesh Kumar, P. J. George, S. Mukherjee and K. S. Chari, Surface and Coatings Technology, **156**, 253(2002)
4. Yinan Li, Zhang Zebo, Chemical Physics Letters, **247**, 253 (1995)
5. N. Nakayama, et al., Jpn. Appl. Phys. **32**, 1465(1993)
6. S. Prawer, K. W. Nugent and D. N. Jamieson, Diamond and Related Materials, **7**, 106(1998)
7. J. R. Shi, X. Shi, Z. Sun, E. Liu, B. K. Tay and S. P. Lau, Thin Solid Films, **366**, 169(2000)
8. G. Mariotto, C. Vinegoni, L. G. Jacobsohn and F. L. Freire Jr., Diamond and Related Materials, **8**, 668(1999)