§45. Development of Low Z Cone for Effective Additional Heating

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Fast ignition is one of the proposed ways to achieve high fusion energy gain in inertial fusion research. For a successful ignition, it is necessary to transport the energy of fast electrons to the imploded core effectively. However, many researchers have reported that fast electrons were diverged more than expected. In addition, it is concerned that fast electrons are scattered by high-Z plasma generated from gold cone target. This may cause the drop of the energy coupling of the heating laser to the fast electrons. Therefore, low-Z materials, such as diamond like carbon (DLC) and aluminum, are drawing attention as cone materials. However, thick DLC film is needed for make a stand alone DLC cone and there are only a few report about such a thick DLC film. Last year we found the suitable preparation conditions for thick DLC films. This year we succeeded in making stand alone DLC cones and studied characteristics of DLC films by Near edge X-ray absorption fine structures (NEXAFS).

DLC film were prepared on brass conical bars by using plasma–based ion implantation and deposition (PBIID) system. In this system, the RF (13.56MHz) for plasma generation is supplied to the substrate together with a negative high-voltage pulse (-10kV) for ion implantation through a single electric feed-through. Argon and methane plasma is used for target cleaning before deposition. Acetylene gas or toluene vapor is introduced to the chamber after this cleaning. The thickness of DLC film was measured by using a step gauge. NEXAFS spectra were measured by using the beamline BL09A in NewSUBARU synchrotron radiation facility.

Figure 1 shows the relationship between deposition time and film thickness. It is found that the film thickness is increased by an increase of deposition time. It is considered that more than 35 hours deposition time is needed for thick films over 10 micron.

We tried to make stand alone DLC cone. Gold deposited brass conical bars were used for base material. After DLC deposition, tip section of the bar was cut by turning tool and immersed in etching agent. We succeeded in making stand alone cones from 3 hour deposition film and 12 hour deposition film. However, tip of 30 hour deposition film was broken. This is considered that the high residual stress of thick DLC films.

Figure 2 and 3 shows the NEXAFS spectra of DLC films made by acetylene and toluene vapor, respectively. Sharp peak around 285 eV indicated the pi peak is seen in Fig. 3. In addition, there are no recognizable structures in sigma range (290 eV~310 eV). These are nature of sp^3 rich amorphous DLC films. On the other hand, some structures are seen in sigma range in Fig. 4. It suggests the existence of hetero atoms, although more investigations are needed. Therefore, it is considered that the DLC film property is controllable by changing a source material. This is very important for accurate synthesis of high property controlled DLC cone targets in the future.

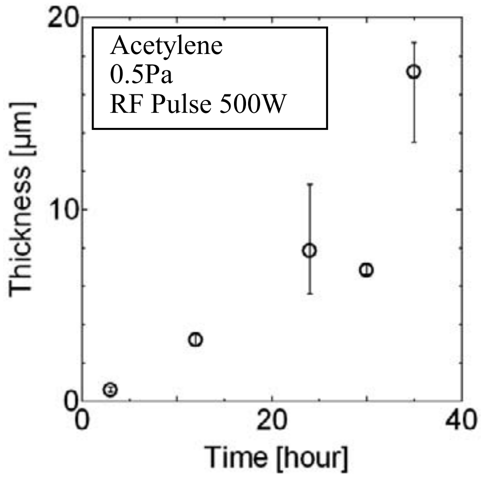

Fig. 1. The relationship between deposition time and film thickness.

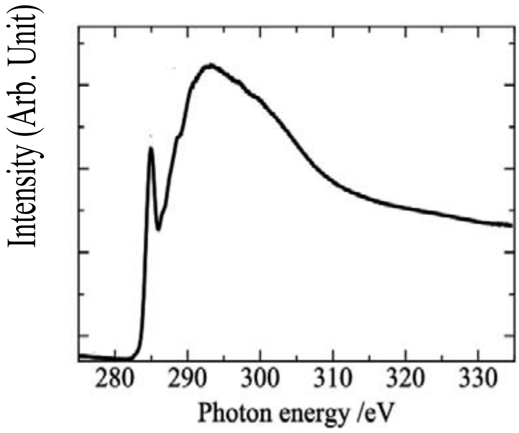

Fig. 2. NEXAFS spectra of DLC films made by acetylene.

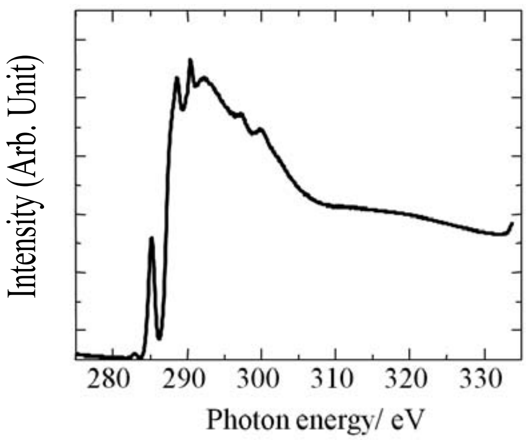

Fig. 3. NEXAFS spectra of DLC films made by toluene vapor.