Production of a Carbon Stripper Foil by an ECR Plasma
ECRプラズマによる炭素荷電交換フォイルの生成

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Nanocrystalline diamond thin films can be durable agains proton radiation like the condition of a carbon stripper foil for the accelerator rings. Not only nanocrystalline diamond, variety of carbon thin films like carbon nanotubes and carbon nanowalls can be prepared by utilizing plasma enhance chemical vapor deposition (PECVD) processes. Sub-atmospheric pressure electron cyclotron resonance (ECR) plasma can produce low temperature hydrogen diluted methane plasma useful for rapid synthesis of carbon material thin films. A hydrocarbon generator based upon the process of hydrogen dissociation on heated carbon surface has been being developed to prepare carbon films coupled to an ECR-PECVD device.

1. Introduction

Low carbon content hydrocarbon plasma can be produced without directly introducing hydrocarbon gas into a discharge. By heating up solid carbon and exposing it to hydrogen plasma, hydrocarbons are released from the surface by the process of chemical sputtering. Variety of carbon deposits are found formed in fusion experiment devices through this mechanism, and this concept is utilized to produce carbon thin films under plasma enhanced chemical vapor deposition (PECVD) conditions.

2. Experimental set up

2-1. ECR plasma source

Low temperature reactive plasmas can be produced with electron cyclotron resonance (ECR) condition. Thus, an ECR-PECVD device as shown in Fig.1 is being assembled equipped with a heated carbon hydrogen dissociator. The equipment has an infrared heater to keep temperature of the substrate at 1000 K temperature. A heat shield is arranged inside of the chamber to reduce heating of the inside wall of the chamber. A ring shaped solid carbon is located right above the heated deposition target, and the magnetized ECR plasma runs through the center of the carbon ring. An enhanced production of hydrocarbon takes place at the surface of the carbon dissociator.

2-2. Carbon dissociator

Performance of a heated carbon hydrogen dissociator is examined with the dissociator structure shown in Fig. 2. It has a 3 mm diameter hydrogen conduit at the center of 10 mm diameter 55 mm long carbon rod. A 0.6 mm diameter 150 mm long tungsten wire is wound around the rod as an infrared heater, and 50 mm radius carbon heat shield blocks the infrared radiation from coming out of the dissociator.

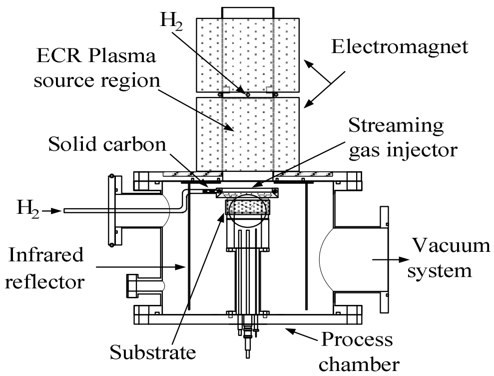

Fig.1. Schematic diagram of ECRPECVD.

3. Preliminary results

The dissociator had been operated without plasma up to about 1000K. Signal of a quadrupole mass analyzer had clearly indicated sizable reduction in CO signal and enhancement of H_2O signal in accordance with the introduction of H_2 gas into the dissociator. Performance test with H_2 plasma is being carried out.

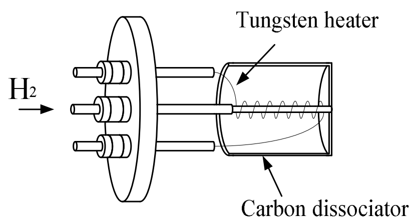

Fig.2. Schematic diagram of carbon dissociator.