Ion energy distribution in high power impulse magnetron sputtering discharge using carbon target

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High power impulse magnetron sputtering (HiPIMS) hasbeen attracted much attention as new ways for hard-coating applications. Typically,the pulse sputtering with peak power density higher than 0.5 kW/cm^{2}with pulse repetition rate of a few hundreds of Hz and pulse width of severaltens μs is categorized into HiPIMS, realizing high energy and high ionization degreeof sputtered species. The energy of the bombarding ions on substrate has astrong influence on film properties. It is essential to elucidate theionization process of sputtered species to control thin-film synthesis. In thisstudy, ion energy distribution function (IEDF) of Ar^+ and $C^+$was measured with energy-resolved mass spectrometry.

A negative pulse voltage with frequency of 400 Hz wasapplied to the carbon target. The input voltage was varied from 760 to 910 V.Pulse duration time was constant about 8 μs. The Ar gas flow rate was 100 sccm,and the pressure was kept at 0.5 Pa. The orifice of mass spectrometer was setat opposite of the target, and the distance was 68 mm.

The IEDF of Ar^+ consisted of low energy andhigh energy components. The number of Ar^+ higher than 2 eV drasticallyincreased with input voltage more than 860V, though the lower energy Ar^+less than 2 eV was not changed. On the other hand, the IEDF of C^+ mainlyconsisted of high energy component, and the number of C^+ increased withkeeping the shape of IEDF. The energy tail extends toward 40 eV for C^+,whereas it is below 20 eV for Ar^+. These behaviors would beexplained due to the ionization process of the species.

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