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Synergy effect between electronic and collisional sputtering: The case of amorphous silicon nitride irradiated with energetic C₆₀ ions

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Amorphous silicon nitride films (thickness 30 nm) deposited on Si(001) were irradiated with 30 – 1080 keV C₆₀ and 100 MeV Xe ions to fluences ranging from 2.5 × 10¹¹ to 1 × 10¹⁴ ions/cm². The composition depth profiles of the irradiated samples were measured using high-resolution Rutherford backscattering spectrometry. Both silicon and nitrogen signals in the film decrease with fluence. The sputtering yields were estimated from the observed RBS spectra. The observed total sputtering yield of C₆₀ increases from 1200 to 4600 when the energy increases from 30 to 1080 keV. The corresponding sputtering yields estimated using the SRIM code are less than 100, suggesting that the electronic sputtering is responsible for the observed large sputtering yields. On the other hand, the observed sputtering yield of 100 MeV Xe is about 500. Considering the fact that the electronic stopping power of 100 MeV Xe ion (16.6 keV/nm) is larger than those of 30 – 1080 keV C₆₀ ions (2 – 10 keV/nm), the large sputtering yields of C₆₀ ions are ascribed to the synergy effect between the electronic and collisional sputtering. In order to estimate such a synergy effect, calculations of the sputtering yield are now in progress using the inelastic thermal spike model taking account of the nuclear stopping power [1]. The result of the calculation will be presented at the conference.

[1] M. Toulemonde, W.J. Weber, G. Li, V. Shutthanandan, P. Kluth, T. Yang, Y. Wang and Y. Zhang, Phys. Rev. B 83 (2011) 054106.

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