Ion implantation effect on Fe2O3 by low energy deuterium ion exposure

Yasuhiro Sakuma*[1], Noriaki Matsunami†[1], Masahiko Kato[1], and Masao Sataka[2]

[1]Nagoya University – Japan
[2]Japan Atomic Energy Agency – Japan

Abstract

Low energy ion implantation into thin film contains the effects due to the incorporation of implanted ions and the energy deposition (the latter is called irradiation effect). It was reported that the lattice expansion in a-Fe2O3 (hexagonal-hematite) film were observed after low energy D irradiation. However, the contributions of incorporation and irradiation effects are unclear to the lattice expansion. In this study, we have investigated the depth distribution of D in a-Fe2O3 film for understanding the contributions of these two effects to the lattice expansion.
Samples were prepared by thermal oxidation of Fe film on SiO2 and characterized by X-ray diffraction (XRD). The film thickness is evaluated to be _˜60 and 100 nm for the present study. Samples were exposed to D-plasma in glow discharge of D2 gas with AC-applied voltage of 1.5 kV. The depth distribution of D was evaluated by nuclear reaction analysis, D(3He, a)H with 1.0 MeV 3He+.
It is found that D's distribute in the entire region of the film deeper than the calculated range distribution (_˜30 nm), implying that the incorporation effect is larger. It is found that with increasing D-fluence, lattice expansion increases to _˜ 0.4 % at 1018 cm-2. XRD spectrum consists of a single broad peak and no visible separation between unirradiated and irradiated parts. This also implies the lattice expansion in the entire region of the film and the large incorporation effect. After samples were kept in air for 8 months, the amount of D-retention decreases, whereas the lattice expansion was unchanged. There is a possibility that H's replace D's. Comparison with 100 keV Ne+ irradiation, the measurement of hydrogen by elastic recoil detection method are underway.

Keywords: iron oxide, low energy deuterium implantation, lattice expansion

*Speaker
†Corresponding author: n-matsunami@nucl.nagoya-u.ac.jp