Magneto-optical properties of Fe nanoparticles embedded in diamond films

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Ferromagnetic nanoparticles (NPs) embedded in a non-magnetic host matrix are known to show unique magneto-optical properties compared to ferromagnetic bulk and film [1-3]. We have so far reported the growth of bcc-Fe NP-containing diamond films by microwave plasma chemical vapor deposition (MPCVD) techniques and the observation of clear magnetic hysteresis even above room temperature due to superparamagnetic blocking in Fe NPs [4]. In this study, we investigated the magneto-optical properties of grown samples by comparing them with the magnetic properties of the same samples.

Fe NP-containing diamond films were grown on diamond buffer layers (~150 nm)/diamond(111) substrate structures by MPCVD techniques. Fe NPs were embedded by inserting an Fe rod (purity: 4N) into a plasma ball to sputter them during diamond growth. Magnetic and magneto-optical properties were measured by using a magnetic property measurement system and a reflection magnetic circular dichroism (MCD) measurement system. For both measurements, a magnetic field (*H*) was applied perpendicular to the film plane, and the measurement temperature was 300 K.

The MCD spectrum for one of the grown samples showed a strong MCD peak near the photon energy (*E*) of 2.4 eV. No such peak was observed for a diamond film without Fe NPs. This peak position is close to *E* of 2.37 eV, at which interband absorption strongly occurs in bcc-Fe [5]. Figure 1(a) shows an MCD-*H* curve measured at *E* of 2.4 eV. The corecivity (~350 Oe) is almost the same as that in the *M-H* curve of the same sample as shown in Fig. 1(b). This result therefore suggests that the obtained MCD properties originate from the magneto-optical transition in Fe NPs embedded in diamond films.

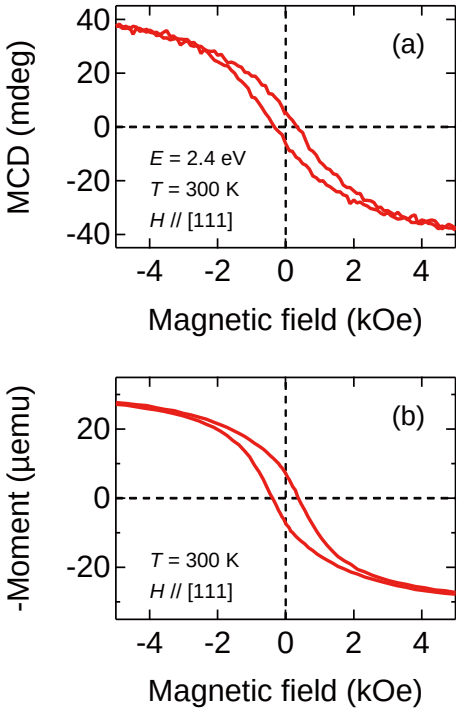

Fig. 1 (a) MCD-*H* and (b) *M-H* curves of Fe nanoparticles embedded in a diamond film.

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