天然永久磁石の放射光X線磁気円２色性分析

中村 教博 [1]; 小嗣 真人 [2]; 大河内 拓雄 [3]; 寺田 健太郎 [4]
[1] 東北大・理・地学; [2] SPring-8/JASRI; [3] 高輝度光科学研究センター; [4] 広大・理・地惑システム

A magnetic domain pattern of maghemite in lodestone by XMCD

Norihiro Nakamura[1]; Masato Kotsugi[2]; Takuo Ohkochi[3]; Kentaro Terada[4]
[1] Earth Science, Tohoku Univ; [2] SPring-8/JASRI; [3] SPring-8/JASRI; [4] Isotope geochemistry, Hiroshima Univ.

https://sites.google.com/site/norihironakamura21/

Lodestone is an only iron ore which behaves as a permanent magnet found in nature. The lodestone mystified early civilization and a period of several hundred years before 1780 was of considerable economic value because of its utility in charging magnetic compass needles. Bandy (1929) summarized some of the field observations associated with the occurrence of lodestone, indicating that lodestone is found at the surface, not in deep mines, and is found at the highest point of outcrops in the most exposed area. Wasilewski (1977) revealed that the mechanism of charging the proto-lodestone is due to either transient magnetic fields associated with lightning discharge currents or presently obscure aspects of magnetization intensity enhancement associated with maghemitization of massive iron ores. This maghemitization suggests the presence of oxidation process of original magnetite, and then the oxidized magnetite has been charged by lightning. Banfield et al. (1994) characterized the nanostructure intergrowth of magnetite and maghemite from the transmission electron microscopy observation, and revealed the significant effect of crystallographic defects in magnetic hardening and in pinning remanent magnetization of lodestone. However, no one has observed a magnetic domain structure for the highly magnetized material. In this presentation, we show a synchrotron X-ray magnetic circular dichroism (XMCD) observation at L2,3 edges of transition element for the magnetic domain structure of lodestone, as well as its X-ray absorption spectroscopy (XAS) at SPring-8. We found the presence of 'speckle' magnetic domain patterns of maghemite nanoparticles in a host magnetite. They appear to be a nearly perpendicular to the surface of positive stray magnetic fields on thin section from the observation of scanning MI magnetic microscopy. Although their three dimensional structure of the maghemite nanoparticles is unknown, it appears that the shape anisotropy of elongate maghemite particles is the origin of magnetic hardening. Such 'speckle' pattern of maghemite grains has been found since Bandy (1929), but we found the 'speckle' pattern of magnetic domains as well as grain shape. We will show the electronic structure of the maghemite nanoparticles from the XAS spectra.