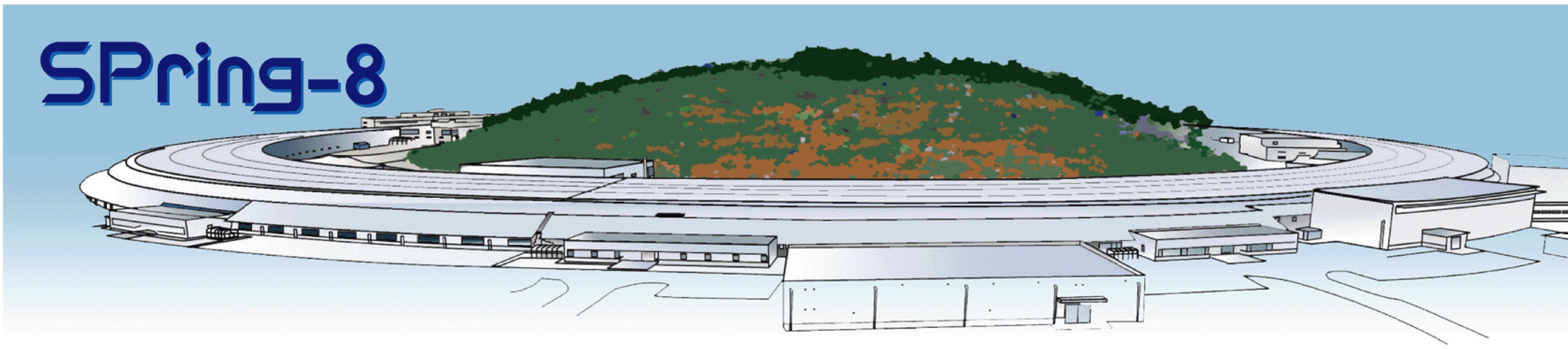

Next-generation magnetoelectronic devices: a wish upon a star

Iron meteorite has been of great benefit to planetary scientists. It shows unique magnetic properties that are significantly different from those of common FeNi alloys. In the Widmanstäten structure of iron meteorite, the important basic question is how the spins of a hard magnetic tetrataenite ($L1_0$-FeNi) thin film couple with the surrounding soft magnetic Fe-Ni alloys (Fig. 1a). From the viewpoint of materials science, the heterogeneous structure near the boundary can be considered as a type of magnetic multilayer system composed of α-FeNi, tetrataenite, and γ-FeNi (Fig. 1b).

In SPring-8, photoelectron emission microscopy (PEEM) has been carried out to study the magnetic properties of iron meteorite associated with the Widmanstäten structure for the first time [1]. magnetic circular dichroic image reveals a unique magnetic domain structure, resulting in the "head-on" magnetic coupling over the interface between the α and γ lamellae (Fig. 2). Such a magnetic domain structure is unfavorable in any synthetic Fe-Ni alloys. Through micromagnetics simulation, the formation of magnetic domains is reasonably explained to be induced by the tetrataenite phase segregated at the boundary in the Widmanstäten structure (Fig. 3).

The magnetic anisotropy energy of tetrataenite shows 3.2×10^5 J/m^3, which is significantly larger than that of a common FeNi phase. In other words, tetrataenite is characterized as a hard ferromagnet with a strong anisotropy. From an ecological viewpoint, new important insights on the synthesis of the tetrataenite phase are attracting considerable attention [2]. Abundant Fe and Ni open the possibility of a rare-metal-free $L1_0$-type ferromagnet to be used in magnetoelectronic applications.

This study was given the most prestigious Japan Institute of Metals Micrograph Award.

References:

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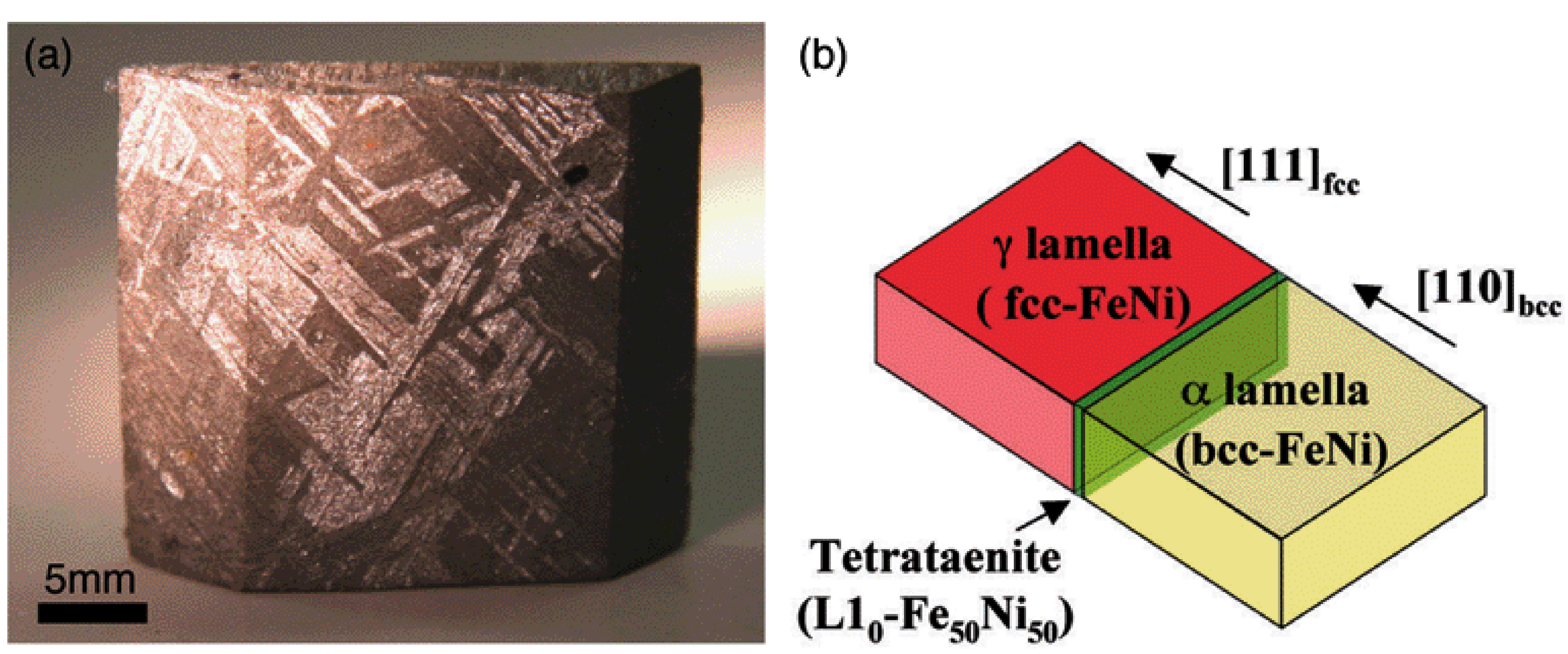

Fig.1
Widmänstaten structure of iron meteorite (a) and modeled structure in interface region (b)

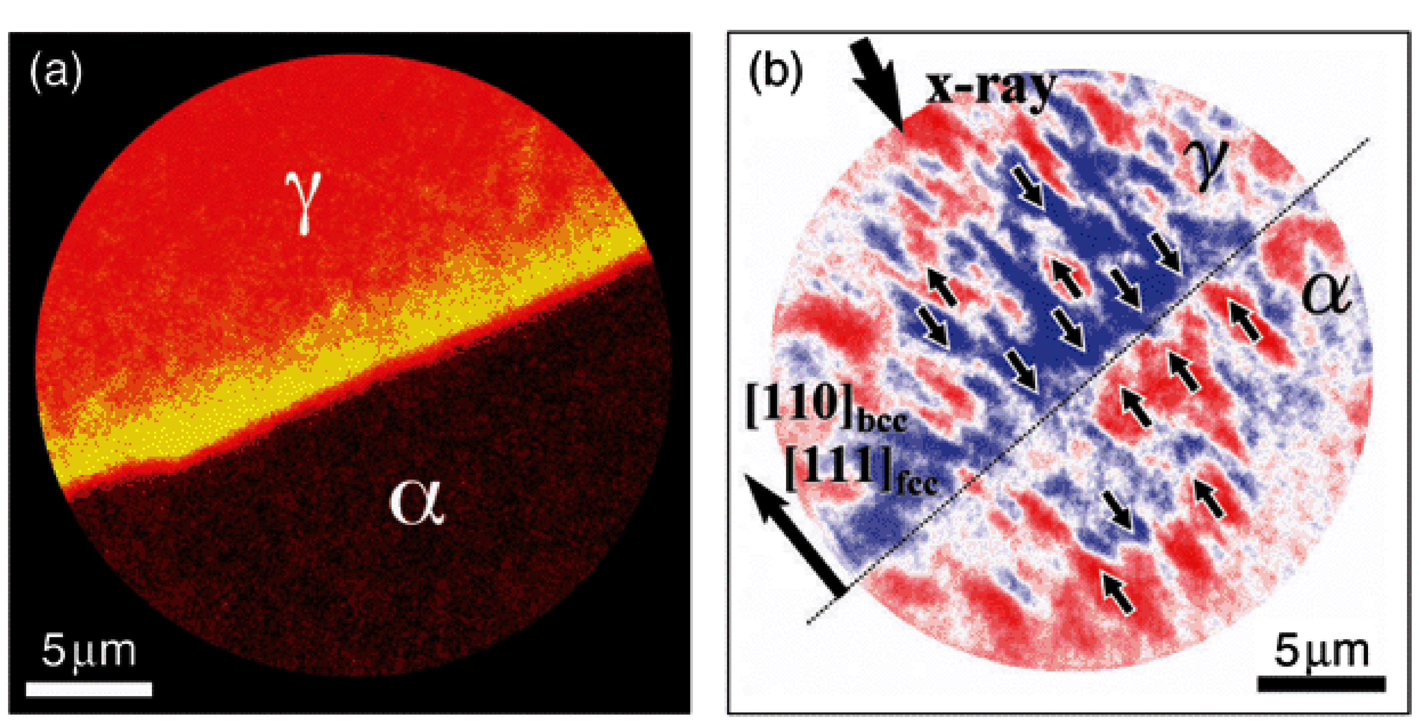

Fig.2
Composition map (a) and magnetic domain image (b) in interface region in iron meteorite obtained by PEEM

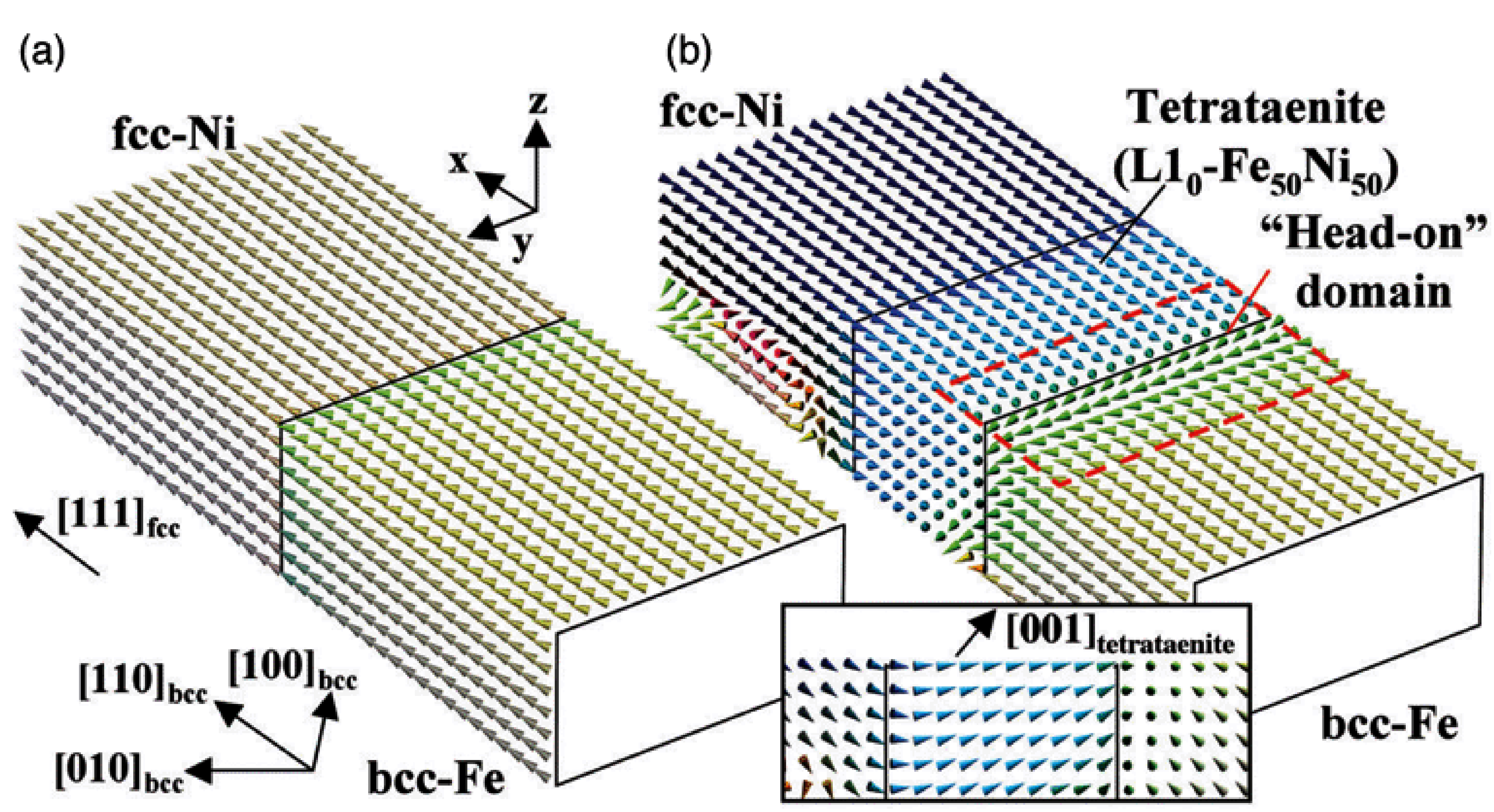

Fig.3
Micromagnetics simulation for Fe/Ni and Fe/tetrataenite/Ni