Microscopic characterization of the nano-domain ferromagnet FINEMET

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It is known that the coercivity H_c in conventional magnetic alloys having a grain size D greater than 1μm increases with decreasing the grain size. In contrast, however, when the grain size is reduced below 0.1 μm, H_c exhibits a drastic decreasing with decreasing D. Therefore, nano-grained magnetic materials have been attracting attentions concerning the utilization as electromagnetic devices. Such fine grained magnetic alloys are realized by deposition of nano-crystals in the amorphous state of Fe-Si-B alloys under a controlled heat treatment, which is known as so-called FINEMET developed by Hitachi Metal. It is important to date that, in J-PARC (Japan Proton Accelerator Research Complex), improving the magnetic response of the acceleration cavity against high radio frequency voltage is essential in order to attain high intense and short-bunched beam.

Muon is a useful tool to investigate magnetism from a microscopic viewpoint. Thus, we conducted μSR experiment at high temperatures up to 850 K with simulating the heat treatment during the production process in order to provide *in situ* information of emerging nano-grained crystals.

In Fig. 1, μSR time spectra at 850 K under zero and transverse fields are shown. As inferred from the difference of the observed asymmetry between zero and transverse fields, there exists non-magnetic portion in the measured sample. Besides, fast depolarization is seen at $t < 0.5$ μs, suggesting the deposition of ferromagnetic grains. The obtained result clearly indicates the emergence of the ferromagnetic domain among the non-magnetic base material in FINEMET.

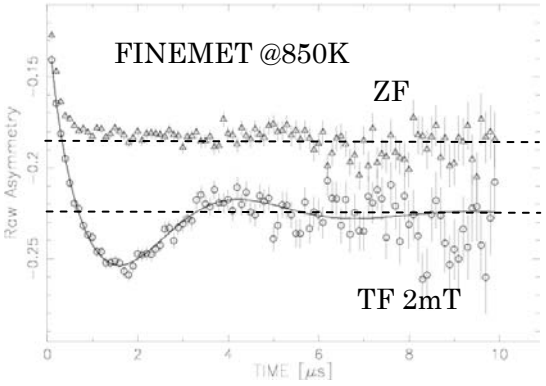

Fig.1: Time spectra of muon spin polarization in FINEMET at 850 K measured under zero and transverse magnetic fields.