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## Comparison of crystallographic structures of Japanese swords in Muromachi and modern periods by using pulsed neutron imaging

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Japanese swords are interesting cultural heritage from metallurgical point of view due to its peculiar characteristics. Its making process is not fully understood even now. Crystallographic information will be useful to understand metallurgical characteristics and to know making process. Non-destructive analysis is desired to obtain the crystallographic information for such valuable samples. Neutrons are powerful tool to study metallic cultural heritages due to their high penetrating power and capability to give crystallographic information [1]. Bragg edge imaging gives real-space distributions of bulk information in a crystalline material. In addition, by analyzing position dependent Bragg edge spectra, quantitative crystallographic information can be obtained [2].

There were five traditional styles (Gokaden) of Japanese sword-making in the Koto (old sword) age; A.D. 987–1596. The crystallographic characteristics will depend on areas and ages of the swords. Therefore, systematic study is recommended for comprehensive understanding. As one of such researches, we performed pulsed neutron imaging measurements on three swords in Muromachi period (14–16 centuries), and one sword in modern period as a reference.

The experiments were performed at the Energy-Resolved Neutron Imaging System, RADEN at J-PARC [3]. Each sword was measured at three places with a counting-type 2D detector. The transmission data were analyzed using RITS code [4]. Quenching area was more clearly observed in the modern sword than in the old ones. There was difference in distributions of lattice spacing. Detailed analysis results will be presented.

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### References

- [1] Salvemini, F.; Grazi, F., Peetermans, S., Civita, F., Franci, R., Hartmann, S., Lehmann, E., Zoppi, M. Quantitative characterization of Japanese ancient swords through energy-resolved neutron imaging. *J. Analytical Atomic Spectrometry* 2012, 27, 1494-1501.
- [2] Shiota, Y.; Hasemi, H.; Kiyonagi, Y. Crystallographic analysis of a Japanese sword by using Bragg edge transmission spectroscopy. *Phys. Procedia* 2017, 88, 128–133.
- [3] Shinohara, T.; Kai, T.; Oikawa, K.; Segawa, M.; Harada, M.; Nakatani, T.; Ooi, M.; Aizawa, K.; Sato, H.; Kamiyama, T.; Yokota, H., Sera, T., Mochiki, K., Kiyonagi, Y. Final design of the Energy-Resolved Neutron Imaging System “RADEN” at J-PARC. *J. Phys. Conf. Ser.* 2016, 746, 012007.
- [4] Sato, H.; Kamiyama, T.; Kiyonagi, Y. A Rietveld-type analysis code for pulsed neutron Bragg-edge transmission imaging and quantitative evaluation of texture and microstructure of a welded  $\alpha$ -iron plate. *Mater. Trans.* 2011, 52, 1294–1302.

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