Non-invasive characterization of ancient Japanese helmets through Neutron Imaging

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Japanese swords and armours have always been very attractive to the western culture because of their distinctive styles and technological features, which are considerably different from the corresponding objects familiar to western culture. Among the various components of the samurai's armour, the kabuto assumes, for obvious reasons, considerable importance. The kabuto of the traditional samurai armour is a kind of helmet, typically made of steel components, assembled in ways peculiar to the particular manufacturing school [1]. Here, the technological skill of the craftsman might reach the best results in joining lightness and effectiveness to defend the most important organ of the samurai's body: the head. In addition, being the most visible part of the warrior from a distance, the helmet assumed also the role of the distinctive sign of a leader in battle. Thus, not only effectiveness, but also elegance and visibility became necessary qualities for the samurai's helmet [2].

Much literature exists about Japanese swords, but far less is known about the technology of Japanese helmets. So, an international team of scientists and curators decided to work together, to investigate the construction of one of the most critical components of the Japanese armour. These objects are quite rare and, when found in museums, are usually in an excellent state of conservation, being considered masterpieces representative of Japanese culture. For this reason, any detailed study of these artefacts must rely on non-invasive techniques and it was decided that thermal and cold neutron techniques should be employed for this investigation.

Here, we present novel results from a non-invasive examination, conducted thought neutron imaging techniques, of two kabuto attributed to the 17th Century. The two chosen helmets are antithetical in their complexity: while the first one is characterized by a unusually complex shape, the second is made of a large set of relatively simple components, assembled in a very complex structure. Preliminarily, neutron diffraction techniques have been applied to the study of kabuto to obtain detailed information on bulk properties (e.g. phase composition, texture, residual strain distribution) [3]. Complementary, neutron imaging experiments (radiography and tomography) carried out at the ICON and NEUTRA beamlines, operating at the neutron source SINQ (CH), have allowed to determine the inner metal structure and manufacturing techniques of these beautiful examples of past technology, revealing some otherwise invisible details [4].

1. Kozan Sakakibara 1800 The manufacture of armour and helmets in 16th century Japan:(chûkokatchû seisakuben),; translated by T. Wakameda, revised by Koop, A. J., and Hogitarô Inada, 1912; revised and edited by Russell H. Robinson, The Holland Press, London 1963.

2. C. Sinclaire 2004 Samurai: The Weapons and Spirit of the Japanese Warrior (The Lyons Press, GUILFORD).

3. A. Fedrigo et al. 2013 Neutron diffraction characterization of Japanese armour components, J. Anal. At. Spectrom., 286, 908 −915. 4 F. Salvemini et al. 2013 Revealing the secrets of composite helmets of ancient Japanese tradition (accepted on EPJ plus).

Summary

We present novel results from a non-invasive examination of two kabuto (helmets), made in Japan in the 17th Century. Neutron Imaging experiments (radiography and tomography) have allowed to determine the inner metal structure and manufacturing techniques of these beautiful examples of past technology, revealing some otherwise invisible details.

Primary author: Mrs SALVEMINI, Filomena (Istituto dei Sistemi Complessi-Consiglio Nazionale delle Ricerche)

Co-authors: Dr WILLIAMS, Alan (Wallace Collection, W1U 3BN London, United Kingdom); Mrs FEDRIGO, Anna (ISC-CNR); Dr SCHERILLO, Antonella (Science and Technology Facility Council, ISIS Neutron Source, OX11 0QX Didcot, United Kingdom); Dr LEHMANN, Eberhard (Paul Scherrer Institut, SINQ Neutron Source, 5232 Villigen, Switzerland); Dr CIVITA, Francesco (Museo Stibbert, 50100 Firenze, Italy); Dr GRAZZI, Francesco (CNR-ISC); Dr ZOPPI, Marco (Consiglio Nazionale delle Ricerche, Istituto dei Sistemi Complessi, 50019 Sesto Fiorentino

(FI), Italy); Dr VONTOBEL, Peter (Paul Scherrer Institut, SINQ Neutron Source, 5232 Villigen, Switzerland); Dr HARTMANN, Stefan (Paul Scherrer Institut, SINQ Neutron Source, 5232 Villigen, Switzerland)

Presenter: Mrs SALVEMINI, Filomena (Istituto dei Sistemi Complessi-Consiglio Nazionale delle Ricerche)

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