
ASIAN ART MUSEUM TECHNICAL REPORT

ACCESSION NUMBER: B83M12

OBJECT: Suit of Armor

CULTURE/PERIOD/CENTURY: Japan/ 1500 - 1600

MEDIUM/MATERIALS/TECHNIQUE: Iron, lacquer, copper alloys, silk, and gilding.

Conservator: E. Saetta

Date: 4.21.2011

Materials Analysis Overview

Sample and Location	Analytical Method	Finding
<i>Do</i> , red lacings	Optical microscopy	silk
<i>Suneate</i> , straps	Optical microscopy	wool
<i>Kuwagata</i> (crest) PL rear and front	XRF	gilded copper alloy (Cu-Zn)
<i>Kuwagata</i> (central decoration) center	XRF	<i>shakudo</i> alloy/patina
<i>Kote</i> , toggle	XRF	gilded copper alloy
<i>Kote</i> , chain mail	XRF	iron

Methods of Analysis:

- X-Ray Fluorescence Spectroscopy
- Optical Microscopy
- X-Radiography

X-Ray Fluorescence Spectroscopy

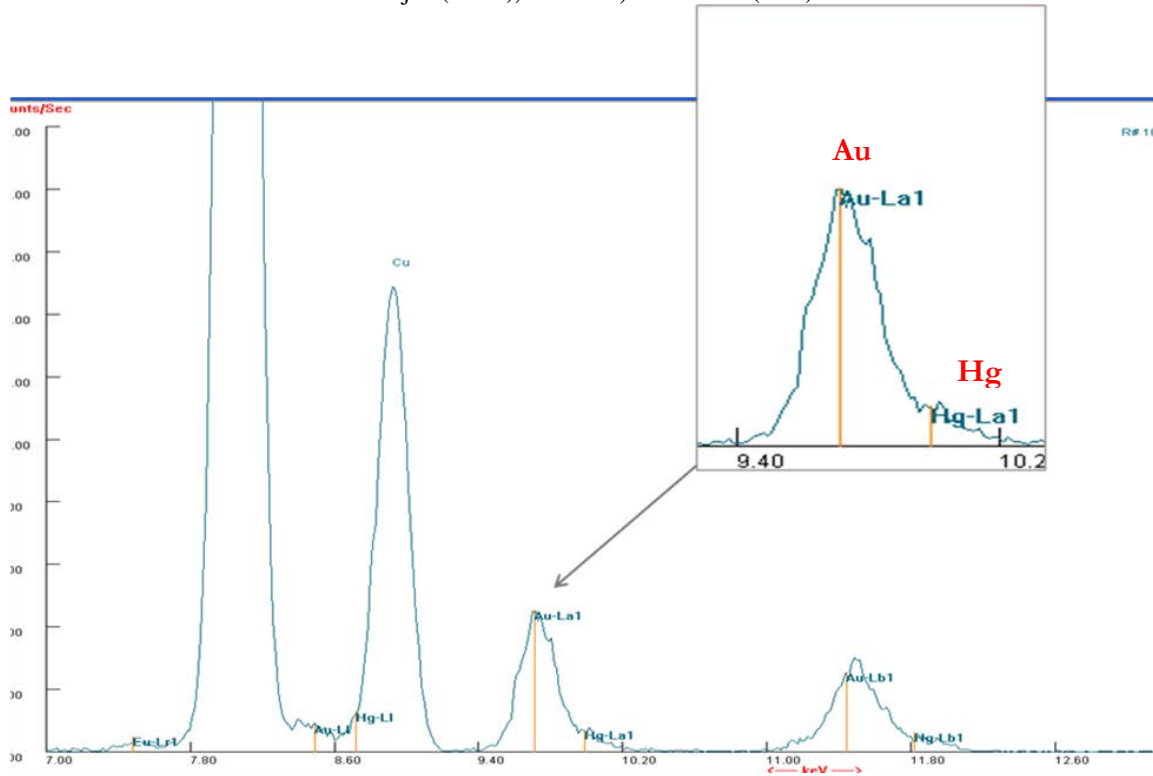
X-Ray fluorescence spectra were collected using a Niton XL3t-900 portable x-ray fluorescence spectrometer. The excitation source was a silver (Ag) anode operating 3-8 mm beryllium acquisition window at 50 kV max voltage. The x-ray beam was directed at the target through a 3-8 mm acquisition window, (Helium purge for light elements). X-rays were detected using a thermoelectrically controlled, energy dispersive (EDS¹) Si-PIN diode detector with a resolution of 220 keV or less at full width of half maximum (FWHM) height of the peak at 5.9 keV (K-alpha for Mn). Spectra were collected for 60 - 90 seconds. Spectral interpretation was performed using the NDTTr version 7.1.1. Analyses were carried out in the conservation laboratory of the Asian Art Museum by conservator E.Saetta.

¹ Energy dispersive spectra (EDS): single, simultaneous detection of all wavelengths. Resolution is in a range of 150-250 eV.

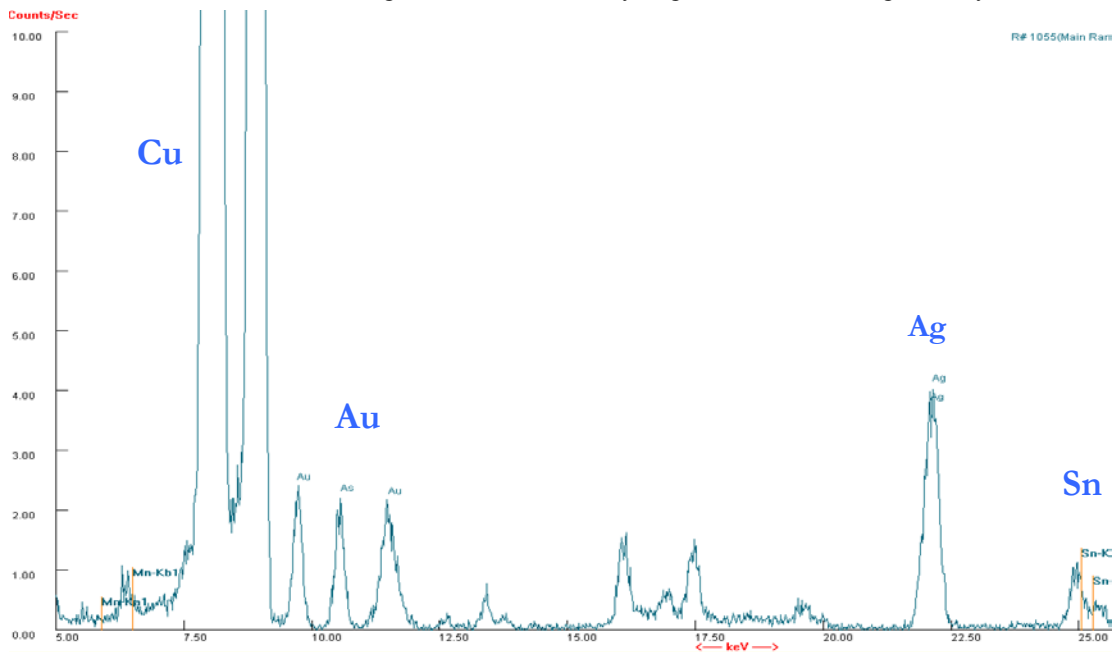
X-Ray Fluorescence Spectroscopy Analysis

Location	Pb	Hg	Au	Ag	Sn	As	Zn	Cu	Ti	Ni	Fe
Kuwagata (horn) Av. 3		t	m	t	t	t	M	M			
Kuwagata (central decoration) Av.2			m	t	t			M	t	t	
Kote, toggle	m		m					M			
Kote, chain mail	m				t						M

M major (>25%), *m* minor, and *t* trace (<1%)



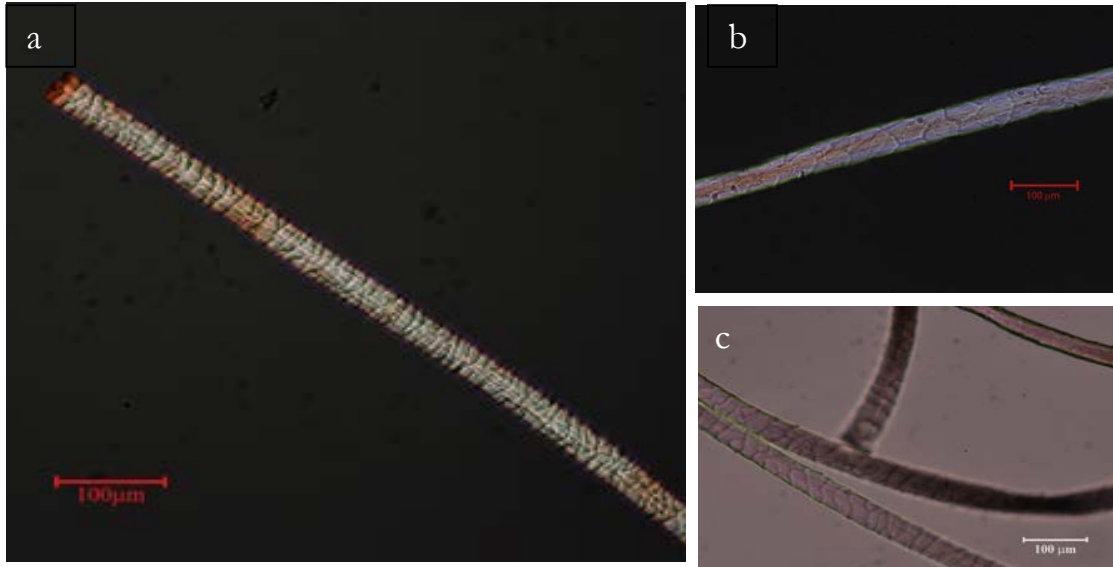
XRF Spectrum of *kuwagata* (helmet crest) showing peaks of copper (Cu), zinc (Zn) and tin (Sn) of alloy substrate, and gold (Au) and mercury (Hg) from (worn) fire-gilded layer.



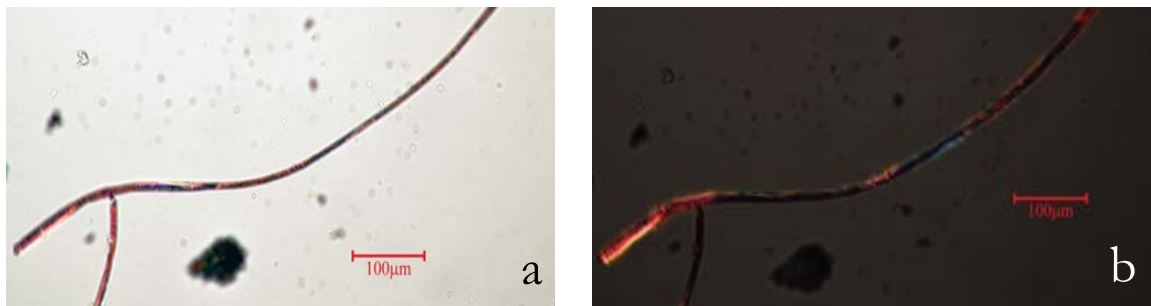
XRF Spectrum of *kuwagata* (helmet crest) with peaks of copper (Cu), gold (Au) and silver (Ag), typical of a *shakudo* patina. (95-97% CU, 3-25% Au) (Untracht O. 1982 Jewelry Concepts and Technology Doubleday & Co. Inc. : 666-676)

Optical Microscopy

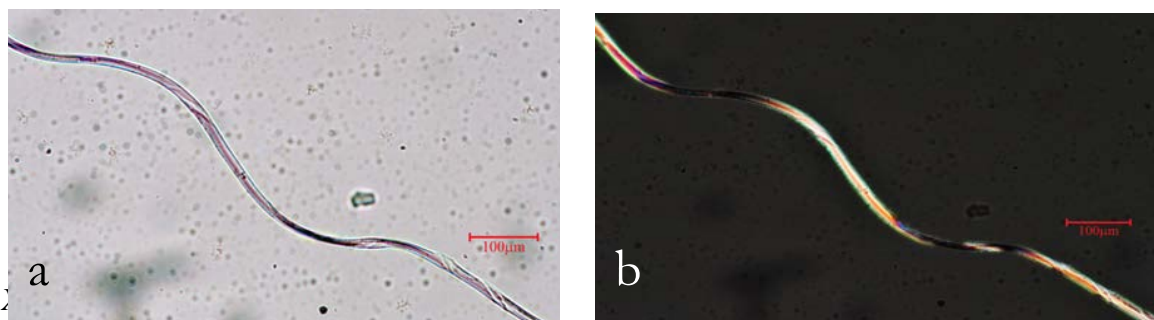
Samples were mounted in **water**, analyzed with a Nikon E600 POL, polarizing light microscope and compared to reference samples, mounted in Melt Mount (RI:1.662). Images were captured using a Nikon D80 digital camera and Nikon Camera Control Pro 2 software.



(a) *Suneate* fiber (purple top section), viewed in cross-polarized light, showing typical cuticle of scales of a wool fiber and purple to gray tones (b) wool, McCrone reference slide, viewed in cross-polarized light. RI<1.662 and (c) wool reference from Testfibers Inc. viewed in cross-polarized light.



Red silk lacing of *dō*, viewed in (a) plane polarized light and (b) cross polarized light (in water). Fibers display typical optical properties of silk: in plane polarized light they appear translucent red (because of dye), with pink and blue edges (brighter in cross-polars) and distinct smooth edges. RI<1.662



Silk (cultivated) McCrone reference slides viewed in (a) plane polarized light and (b) cross polarized light (in melt mount RI:1.662)

X-Radiography

Radiographs were made using **Kodak MX125** imaging plates. Exposure was **80 kV, 90** seconds at **6 mA, 30"** FFD, with **3 mm Al** filtration. Radiography was done using a **Gulmay 320 kV** x-ray tube with a **5 mm** standard focal point.

