


Object Number	K570	Description	Hilt-collar in gold, of narrow form, combining a band of filigree and a band of garnet cloisonné. Catalogue no. 158.
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	Sample Description and location.
	Conservation sample 3 'paste from foil' analysed. Numbered K570-1 for FTIR analysis.

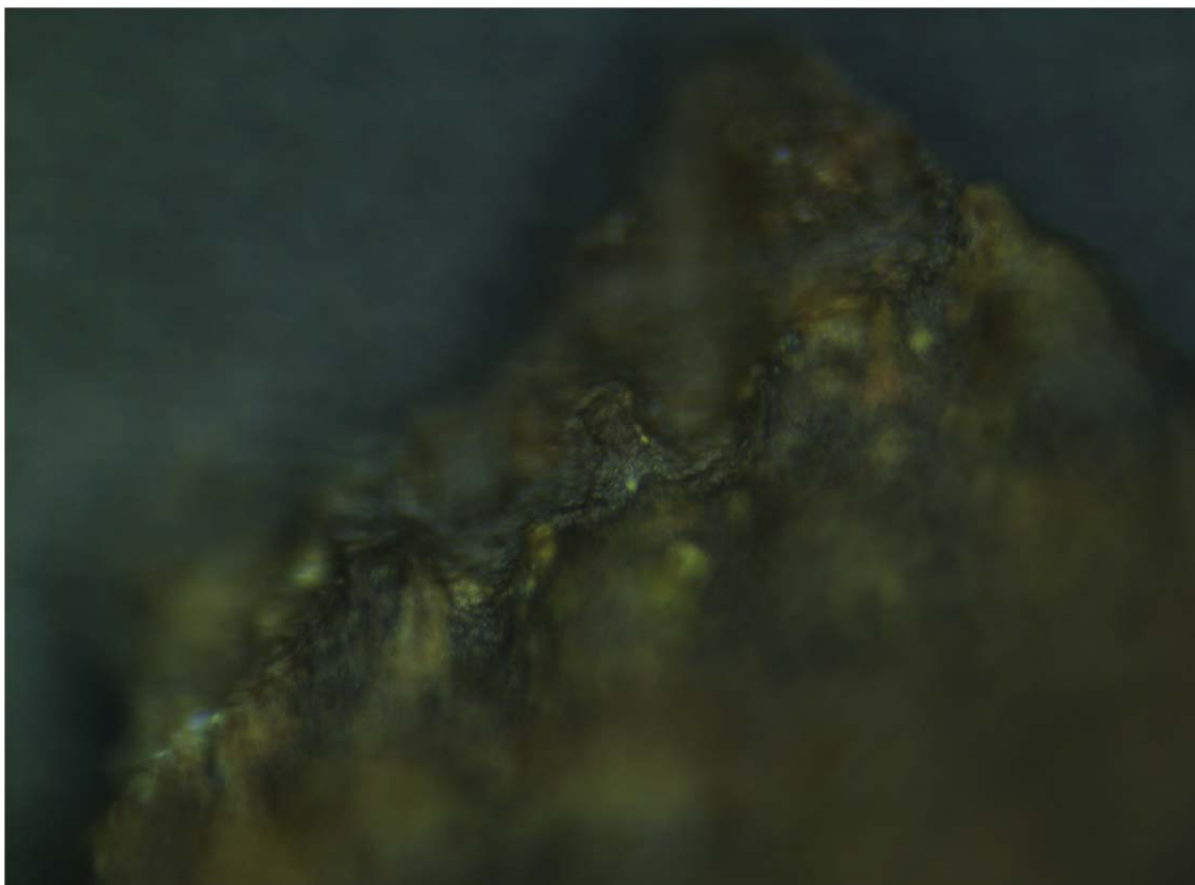


Figure 1. Detail of FTIR analysis area for sub-sample K570-1-1.

FTIR Analysis

Comments: Spectrum K570-1-1 (top, blue) appears to be a mixture of a keratin based animal glue such as hoof glue and beeswax. The FTIR spectra for keratinous materials exhibit characteristic bands for amide I (C=O stretching) between 1700 and 1600 cm^{-1} , and amide II (CN stretching and NH bending) between 1560 and 1500 cm^{-1} , and a broad band centred at around 3300 cm^{-1} related to N-H stretching. A doublet between 3000 and 2800 cm^{-1} relating to C-H stretching of methylene groups are characteristic of keratinous proteinaceous materials. (Welsch et al. 2012, Kennedy et al. 2013, Mansilla et al. 2011, Derrick et al. 1999). In oxidised keratinous materials such as the oxidised horse hair shown in Fig. 2, an intense peak at about 1030 cm^{-1} is attributable to S=O bonding in cysteic acid. (Welsch et al. 2012, Kennedy et al 2013, Mansilla et al. 2011). This peak should be interpreted with some caution in this sample however as silicate based material such as is found in earth minerals also exhibit a sharp band at approximately 1000 cm^{-1} which relates to Si-O bonding. The peak at 1030 cm^{-1} may derive from cysteic acid in oxidised keratinous tissue, silicate based earth minerals deliberately added to the paste or from the burial environment, or a combination of both.

The FTIR spectrum for beeswax is characterized by dominant absorption bands around 2950 cm^{-1} and 2850 cm^{-1} that relate to C-H stretching of the methylene (CH_2) groups, a band at 1740 cm^{-1} that relates to C=O bonding characteristic of the ester groups, a band around 1460 cm^{-1} relates to C-H bending, and a doublet between 720 and 730 cm^{-1} relating to non planar skeletal deformation vibrations of long chain hydrocarbons (Derrick *et al* 1999, Birshtein and Tul'chinskii 1977). The bands in the region 1350 - 1180 cm^{-1} may be assigned to a phenomenon known as a 'band progression' present in fatty acids and fatty acid esters which result in a series of evenly spaced bands in this region. These are due to wagging and twisting vibrations of successive carboxyl coupled methylene groups (Baeten et al. 2010) shown in more detail in Fig.3.

Representative Spectrum

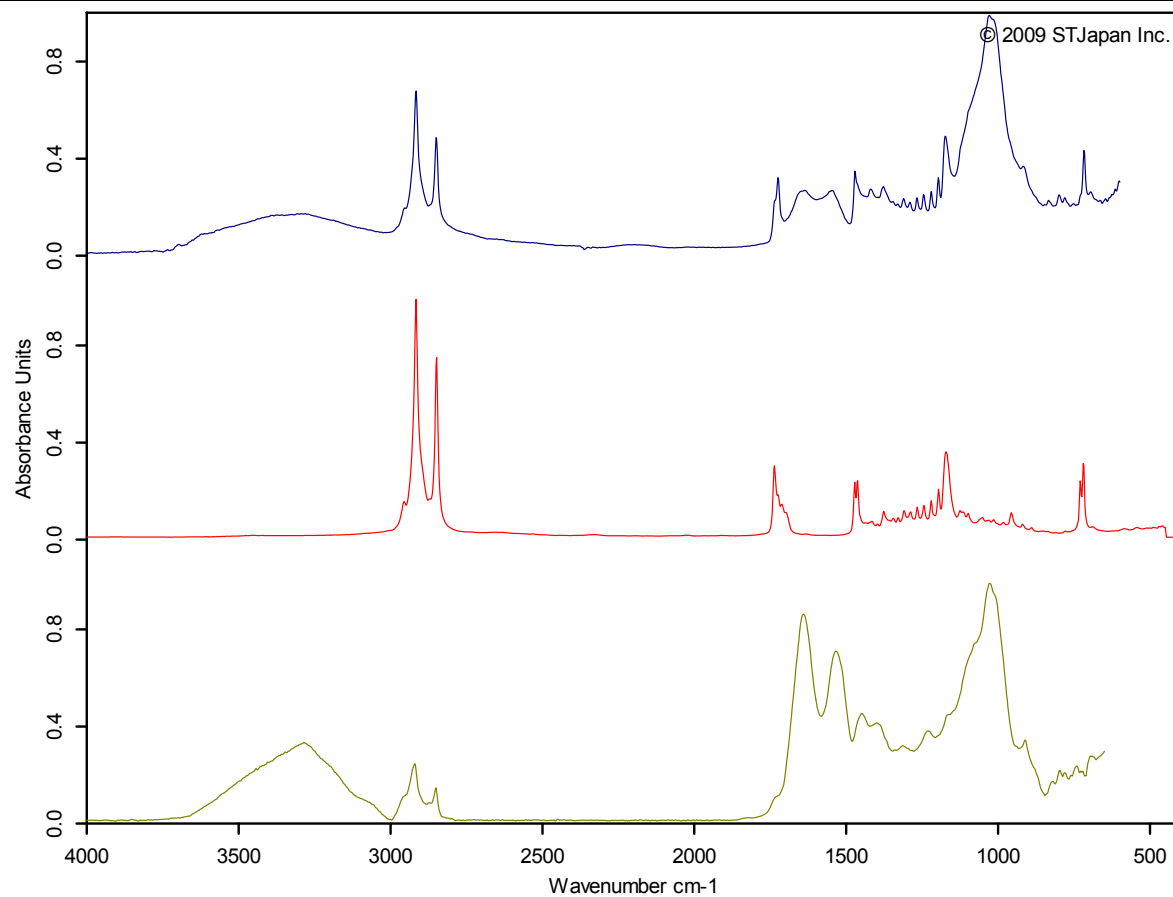


Figure 2. Top (blue) K570-1-1. Middle (red), Beeswax reference sample, ST Japan 2009. Bottom (green) Oxidised horse hair reference spectrum, ST Japan 2009.

Representative Spectrum

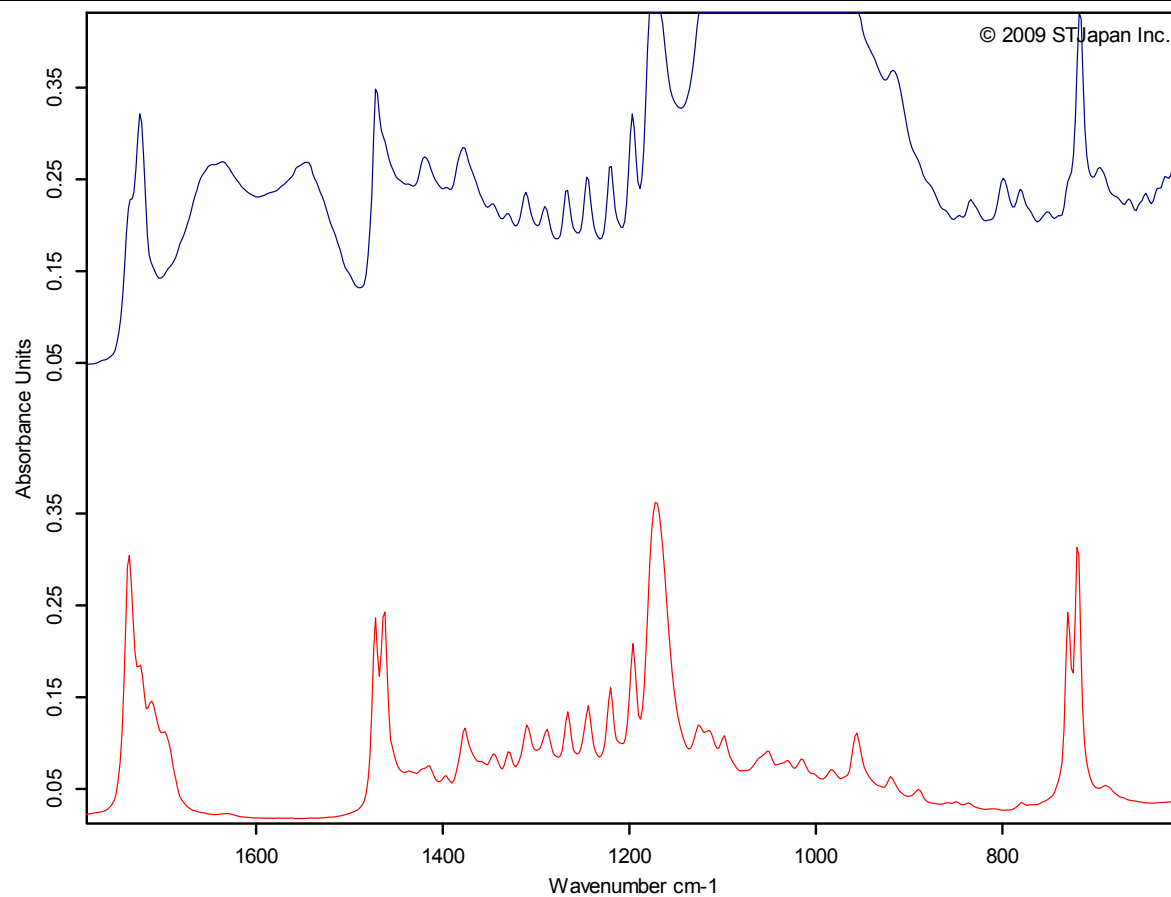


Figure 3. Detail of 600-1800 cm⁻¹ region comparing spectra for K570-1-1 (top, blue) and beeswax reference sample, ST Japan 2009 (bottom, red).

Comments: Spectrum K570-5-5 (top blue) is a green coloured sub-sample of K570-5 and shows a clear spectral match with Malachite (middle, green) with additional silicate material (bottom, red) likely related to corrosion products from copper in the gold components of the object. The mineral, pigment, and corrosion product malachite is basic carbonate of copper $\text{Cu}_2\text{CO}_3(\text{OH})_2$ (Scott 2002, Gettens & Fitzhugh 1974, Luo et al. 2010). The pale green coloured corrosion product malachite, found in association with some organic samples, is likely formed from interactions between copper oxide from the gold components in some objects, and CO_2 rich ground water from the burial environment. Malachite is a hydrated carbonate, and as such has a broad absorption band due to O-H stretching between 3700 and 3100 cm^{-1} that incorporates peaks at 3400 and 3320 cm^{-1} (Derrick et al 1999). Additional peaks relating to O-H bending are found between 1100 and 1000 cm^{-1} . The split peak between 1530 cm^{-1} and 1350 cm^{-1} relates to C-O stretching, and a complex series of peaks between 900 and 650 cm^{-1} arise from O-C-O bending vibrations from the hydrated carbonate ion (Derrick et al. 1999).

Representative Spectrum

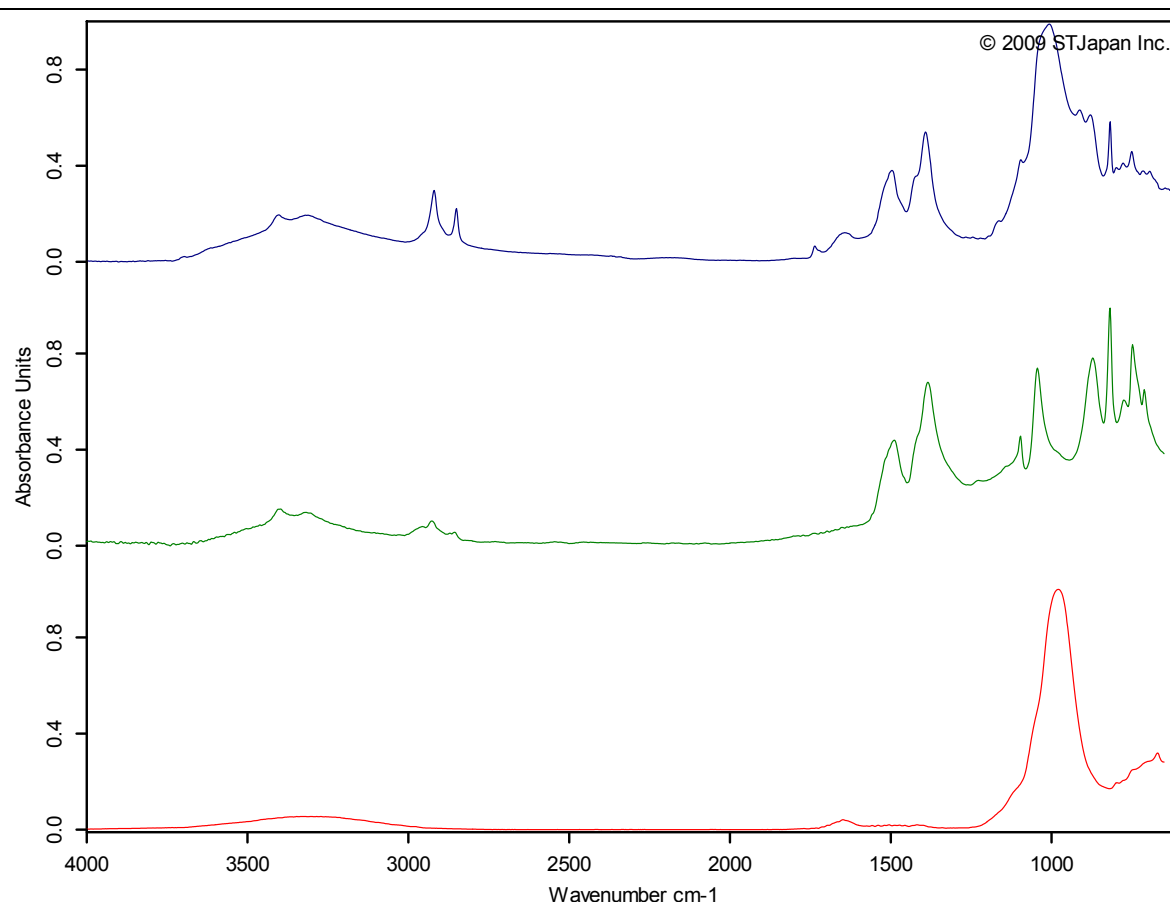


Figure 4. Additional spectral set showing spectra for FTIR analysis sub-sample K570-5-5 (top, blue), with Malachite reference sample (middle, green), ST Japan 2009, and Alumino silicate reference sample, (bottom, red), ST Japan 2009.