



	Experiment title: Decay mechanism of archaeological silk - Crystallographic investigation of ancient Chinese silk	Experiment number: ME-551
Beamline: ID13	Date of experiment: from: 12/6/03 to: 14/06/03	Date of report: 28/8/03
Shifts: 6	Local contact(s): Christian Riekel	<i>Received at ESRF:</i>
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Report:

Archaeological background

Famen-si, situated 100 km from the former capital Xi'an in Central China, is a monastery renowned for the wealth of its treasury especially during the Tang period (618-907 AD). When in the early 1980's parts of the Famen-si pagoda collapsed, an unknown hidden vault was found with (amongst others) silk textiles, which had suffered severely from the long burial. Nevertheless, the dry climate of Central China favoured the survival of the silk and gave archaeologists, conservators and scientists the unique opportunity to investigate textile objects more than thousand years old.

The present study focuses on the elucidation of the degradation process. Since silk objects are exceptional among archaeological findings, knowledge about degradation mechanisms in the soil is rather limited. The Famen-si silks exhibit different stages in the degradation process, frequently even within one single piece, and this gives the chance to monitor the single steps of decay.

Aim of the study: crystallinity and degradation process

Silk is a natural polymer built up by a sequence of amino acids. The structure is partially crystalline, and the SR part of our investigation aimed at the determination of crystallinity in different stages of decay. In regard to stabilisation and conservation of the fragile archaeological silk, this correlation is rather important: different stabilizing agents interact with the amorphous and the crystalline domains in different ways. Therefore, knowledge of the degree of crystallinity is important for the choice of stabilizing agents. The Famen-si silks may be regarded as test cases for the development of adequate stabilization methods for archaeological silks, that cannot be saved by controlling environmental conditions alone.

First results

Single silk fibres at different stages of degradation were investigated using the ID13 microgoniometer. In order to avoid radiation damage as far as possible, the samples were cooled down to 100K. Although most tissues are intact in appearance, they are very fragile and often crumble at the slightest touch.

All fibres gave the characteristic *Bombyx mori* (silkworm) pattern, well-known from investigations of modern silk. The patterns of some samples, which have been decomposed to amorphous lumps, show no single reflections but just diffuse rings.

Quantitative conclusions from X-ray patterns are problematic in general; the results, nevertheless, indicate that the degree of crystallinity of the degraded samples is unaltered in comparison to modern silk. The degradation process seems to start in the amorphous regions and destroy these parts. In this stage the fibres keep their shape and morphology but they become very fragile and tend to crumble. By the lack of the connecting amorphous material crystallites disconnect very easily and the fibres fall to dust. Most of the Famen-si silk belongs to this category. In the last step of the degradation process, crystalline parts deteriorate and only a formless material remains. This first rough model of the decay process agrees with suggestions given by some authors in literature (see M. Becker *et al.*, 1996, for example).

The crystallographic work will be complemented by further spectroscopic and REM/EDX studies.

References

M. Becker, Y. Magoshi, T. Sakai and N.C. Tuross, *Studies in Conservation* **42** (1997) 27-37

