Journal of Thermal Analysis, Vol. 25 (1982) 95–100

ON THE IDENTIFICATION OF TEXTILE FIBERS BY TG

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A new type of deposit has been observed on the inside inner surface at glass exhibition cases for textiles. By thermogravimetric methods the main part of the coating has been shown to consist of wool fibers. The origin is the textile itself, and the fibers have been transported due to an electrostatic charge induced by polishing from the outside. Such damage can be avoided by grounding the boxes.

In 1910 a large cover, joined together at a later date by five long and narrow textile strips of which four were worked in a kind of soumak technique and one in double cloth, was found in the parish church of Överhogdal in the province of Härjedalen in Northern Sweden. The base is made of non-coloured linen and the figures of wool in different colours [1]. They are now on show in the Jämtland's Museum in Östersund and might originate from the beginning of the 12th century. The pictorial content is generally taken to be based on the Völsunga saga and the story of Sigurd Fafnersbane.

The textiles are being exhibited since 1956 in separate cases made for each piece of fabric. They consist of a stainless steel frame, 50 x 200 cm, covered with thick glass plates on both sides, 8 cm apart, and sealed with rubber. Twenty-five years ago the textiles were rinsed in distilled water, dried at room temperature and mounted vertically on thin, stretched linen fabric. This arrangement has been kept and shown at museum temperature since then.

In 1981, a whitish deposit, different from a previously reported case [2], was observed on the inside of the front glass.

EXPERIMENTAL

The thermogravimetric measurements were performed with Perkin-Elmer TGS-2, equipped with a Programme 4 System. Dynamic air, 50 ml/min, and a heating rate of 10°/min was used throughout the experiments. Sample amounts of the order 0.2-0.4 mg were tested. To obtain X-ray fluorescence data an instrument manufactured by Rigaku was used. The X-ray source is a rhodium-tube of which traces are seen in Fig. 1. The X-ray diffraction

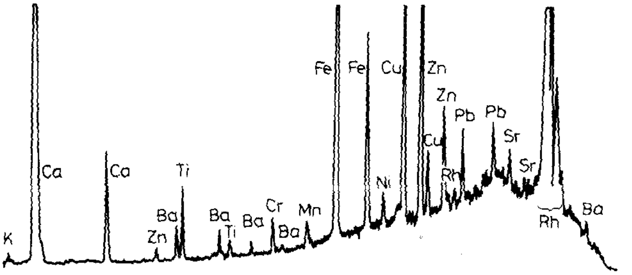

Fig. 1. X-ray fluorescence analysis of the coating material of the inside of glass cases

analysis were made with a Guinier-Hägg focusing camera with strictly monochromatized $CuK_{\alpha 1}$-radiation.

Identification and examination of the coating

The coating gives a patchy impression by looking at it from a distance.

A microscopic examination shows the material to be very heterogeneous. The main component is a soft, fibrous mass containing a few pieces with a specific appearance and also dispersed small crystals.

Another non-destructive characterization method, X-ray fluorescence, reveals a large number of chemical elements /Fig. 1/.

By using X-ray diffraction methods crystalline compounds can be identified. In this case the characteristic lines fit a mixture of one form of calcium carbonate, namely calcite, and quartz. Furthermore a very weak pattern of one not too well characterized silicate mineral is present. The total amount of these components is, however, very small /on the order of 5-10%/, and the remaining principal constituent is the fibrous X-ray amorphous part.

In what way can those results be interpreted?

Most elements found by X-ray fluorescence analysis can be related to the crystalline compounds identified by the X-ray diffraction technique. However, iron, zinc, copper manganese, nickel and lead have another origin. So far the reason for the presence of lead cannot be explained, whereas the other metals are essential for biological life and occur in all living matter in different amounts.

But why are these materials found on the glass surface? Have they condensed or have they been transported in another way?

It is more difficult to characterize an amorphous material than a crystalline compound. However, by thermogravimetric analysis techniques the properties of almost any type of substance can be investigated. The weight loss of a material when heated in air is registered and can be used as a "finger print" identification as well as for quantitative analysis.

A known amount of the white coating was heated in air up to around 900°. At certain temperatures it loses weight /Fig. 2/ due to e.g. burning or decomposition. Such steps can be used to estimate the amount of a certain substance in a mixture.

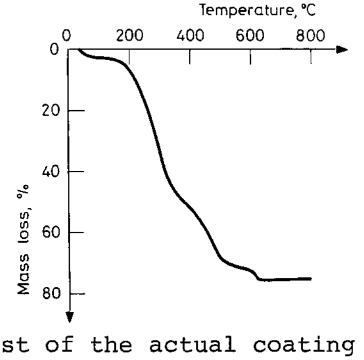

Fig. 2. TG test of the actual coating material.

Calcite gives off carbon dioxide at around 600° and the amount of calcite in the mixture corresponds thus to 10%.

Furthermore, the weight loss curve in Fig. 2 can also be used for identification purposes. By conducting corresponding experiments under the same chemical conditions, characteristic comparison diagrams are obtained of fibers from the old, original linen and wool and of the 20th century materials that are used as substrate /Figs 3-6/.

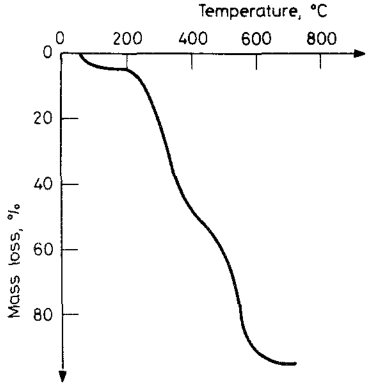

Fig. 3. TG analysis of ancient wool fibers.

The patterns obtained from the coating and from the reference wool fibers, the olds as well as the new, are almost identical.

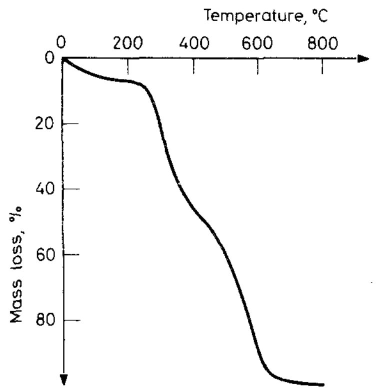

Fig. 4. Reference TG test of modern wool fibers.

According to these results, ageing has not much affected the chemical behaviour. The main difference is that the old materials have a higher ash content.

Old natural materials such as linen, wool etc. have a tendency to lose their normal flexibility due to washing, ageing e.g., and the fibers become somewhat brittle. Several attempts to restore similar materials have been performed in laboratories all over the world but so far has no really good technique been developed.

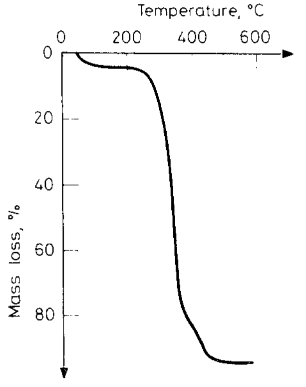

Fig. 5. TG analysis of ancient linen fibers.

Interpretation of the observed data

By the weight-loss curve /thermogravimetric analysis/ it has been shown that the main part ~75%, consists of brittle fibers from the old valuable embrodieries.

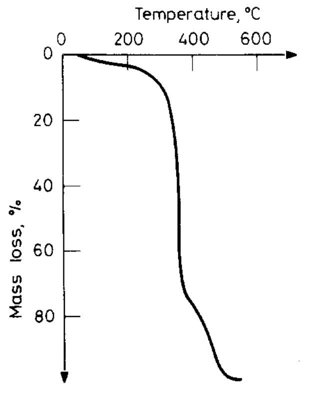

Fig. 6. Reference TG curve of modern linen fibers.

The textile specimens have probably earlier been hanging on a church wall, which was presumably, in the normal fashion, whitewashed with a paint based on natural lime pigments with quartz and silicates as impurities. One explanation of the lead content in the coating is that white lead pigments in paints have also been used.

CONCLUSION

The fibers, which are the main part of the whitish coating on the inside of those glass boxes, originate from the old somewhat brittle linen and wool fabric.

Presumably they have been attracted to the glass surface by an electrostatic charge induced by polishing from the outside.

We now try to minimize such loss of material by grounding the boxes.

REFERENCES

1. H. Friedstein, J. Chem. Educ., 58 /1981/ 291-294.
2. M. Nockert and T. Wadsten, Studies in Conservation 23 /1978/ 28-41.

ZUSAMMENFASSUNG - Ein neuer Typ von Ablagerungen an der Innenseite von Ausstellungsvitrinen für Textilien wurde beobachtet. Durch thermogravimetrische Methoden konnte gezeigt werden, dass der Hauptteil der Ablagerung aus Wollfasern besteht. Diese stammen von den Textilien selbst und gelangen infolge der durch Polieren der Aussenseite induzierten elektrostatischen Ladung an die Scheiben. Solche Schäden können durch Erdung der Vitrinen vermieden werden.

Резюме - Наблюдали новый тип отложения на внутренней стороне внутренней поверхности текстильных материалов при их выставке под стеклом. Термогравиметрическими методами показано, что главная часть покрытия состоит из шерстянных волокон. Источником их является сам текстильный материал, а перемещение волокон было обусловлено электростатическим зарядом, наведенным полировкой с внешней стороны. Такое повреждение может быть устранено заземлением витрин.