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Advantages of using TEM when analysing asbestos in ambient air

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Asbestos is an industrial term to describe some fibrous silicate minerals, which belong to the amphiboles or serpentines group. Six minerals are defined as asbestos including: chrysotile (white asbestos), amosite (grunerite, brown asbestos), crocidolite (riebeckite, blue asbestos), anthophyllite, tremolite and actonolite, but only in their fibrous form. In 1973, the IARC (International Agency for Research on Cancer) classified the asbestos minerals as carcinogenic substances (IARC,1973).

The Swiss threshold limit (VME) is 0.01 fibre/ml (SUVA, 2007). Asbestos in Switzerland has been prohibited since 1990, but this doesn't mean we are over asbestos. Up to 20'000 tonnes/year of asbestos was imported between the end of WWII and 1990. Today, all this asbestos is still present in buildings renovated or built during that period of time. During restorations, asbestos fibres can be emitted into the air. The quantification of the emission has to be evaluated accurately. To define the exact risk on workers or on the population is quite hard, as many factors must be considered.

The methods to detect asbestos in the air or in materials are still being discussed today. Even though the EPA 600 method (EPA, 1993) has proved itself for the analysis of bulk materials, the method for air analysis is more problematic. In Switzerland, the recommended method is VDI 3492 using a scanning electron microscopy (SEM), but we have encountered many identifications problems with this method. For instance, overloaded filters or long-term exposed filters cannot be analysed.

This is why the Institute for Work and Health (IST) has adapted the ISO10312 method: ambient air – determination of asbestos fibres – direct-transfer transmission electron microscopy (TEM) method (ISO, 1995). Quality controls have already be done at a French institute (INRS), which validate our practical experiences. The direct-transfer from MEC's filters on TEM's supports (grids) is a delicate part of the preparation for analysis and requires a lot of trials in the laboratory. IST managed to do proper grid preparations after about two years of development.

In addition to the preparation of samples, the micro-analysis (EDX), the micro-diffraction and the morphologic analysis (figure 1.a-c) are also to be mastered. Theses are the three elements, which prove the different features of asbestos identification. The SEM isn't able to associate those three analyses.

The TEM is also able to make the difference between artificial and natural fibres that have very similar chemical compositions as well as differentiate types of asbestos.
Finally the experiments concluded by IST show that TEM is the best method to quantify and identify asbestos in the air.

REFERENCES:

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ISO 10312:95, Ambient atmospheres: Measurement of asbestos fibres, Direct-transfer transmission electron microscopy method, International Standards Organisation , Geneva, 1995

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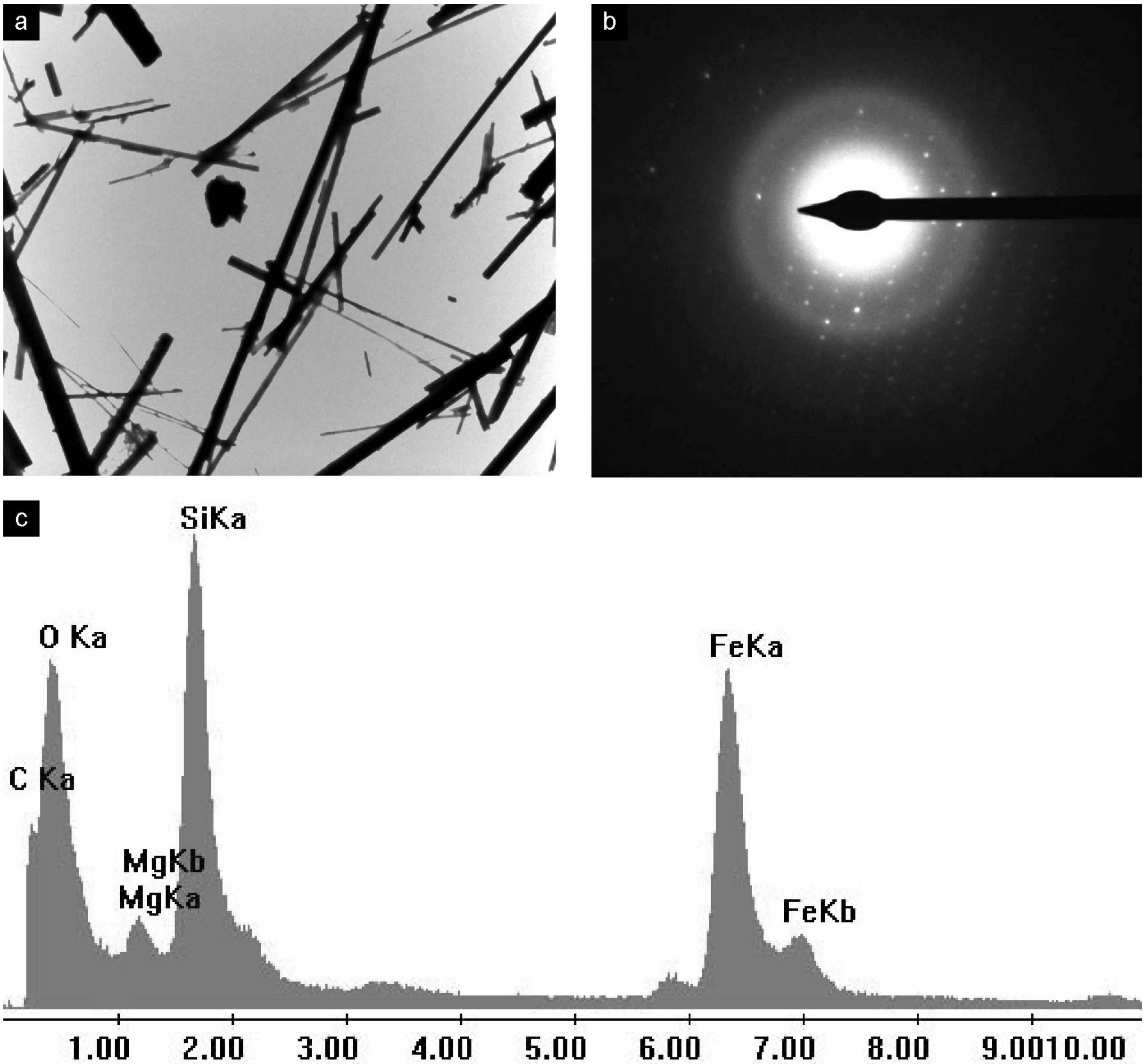

Figure 1. Pictures from TEM (morphology (a), micro-diffraction (b) and EDS (c)) of an amosite fibre

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Textural, chemical and microstructural records during snowball garnets growth

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The growth history of two populations of snowball garnets from the Lukmanier Pass area (central Swiss Alps) was examined through a detailed analysis of chemical zoning, crystallographic orientation and 3D geometry. The first population was collected in the hinge of a chevron-type fold and shows an apparent rotation of 360˚. Microstructural and chemical data reveal a modification of the stress field regime during garnet growth occuring after 270˚ of relative rotation and for XMn = 0.009. Crenulated inclusion trails indicate that the last 90˚ of the spiral curvature was formed under a non-rotational regime associated with flexural folding. Electron Backscattered diffraction (EBSD) maps reveal a crystallographic central domain