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Microscopic Methods for Analyses of Works of Art and Gemmological Objects in Forensic Science

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Forensic analysis is becoming extremely popular thanks to television series. However, the actual practice tends to be different from the TV concept, especially as for the processing period, although possibilities and scope of information might not differ significantly. Microscopic methods are of key importance in the forensic field. First they act as screening methods, when they help obtain basic information about the object being examined, and second they can lead to gaining relevant data for the expert examination completion. A typical field where microscopic methods are irreplaceable is the analysis of art-objects and gemmological objects and other high-worth commodities. These expert analyses, each being specific, do not typically count among routine ones. They cover e.g. material examination of paintings, historical textiles and other antiquities (coins etc.), identification of fragments (from transport vehicles, storage areas, etc.) of historical statues and sculptures with originals, gemstones and jewellery analyses, etc.
A problem often dealt with is the determination of genuineness of art-objects performed in cooperation with outside workplaces and art specialists (paintings, sculptures etc.). The determination of genuineness of declared commodities in the gemmology area is usually easier.
A regular requirement is the use of non-destructive or semi-destructive methods, when microscopic samples (e.g. from paintings or sculptures) are taken by specialized restorers. The analytical methods themselves are in that case non-destructive, i.e. the material is not consumed and it is possible to perform the whole complex of methods on a single sample. Pigments figure prominently in material examination of art works. Their microsamples are processed both in the form of polished section, in order to preserve the whole layer stratigraphy, and by means of fixation of individual single-type samples. A microtom section technique was developed with regard to performance of other analyses (especially FTIR in transmission mode). Mircotom sections are suitable for SEM, microXRD and optical methods as well. The technique has been thoroughly tested and qualified as an alternative or addition to the conventional preparation of polished cross sections through the microsample layers. The success rate of microtome sections preparation markedly broadens the possibilities of microanalytical methods used for identification of fragment material composition. For the purposes of microtom section several different epoxy, polyester and acrylate embedding resins were tested, both model and real fragments were examined. Besides also behaviour of various embedding resins during the analysis of polished and microtom sections was evaluated, as well as their colour shade in white incident light, UV luminescence, effect on X-ray diffractogram and IR spectrum.

Analyses of works of art represent in principle complex expert examinations, in which the following methods are used:
1) optical microscopy in transmitted and reflected light, polarization and fluorescence in visible, infrared and ultraviolet radiation – analysis of fibres, mineralogical and petrological

phases, gemmological objects (inclusion, gas-liquid inclusions, inhomogeneity), paints and pigments,
2) image analysis – determination of quantitative material and measurement attributes (e.g. morphological description of materials (grains) etc.)
3) quantitative colour measurement in micro-scale – microspectrophotometry (for comparison of pigments, fibres, gemmological objects etc.). Measurements are taken in visible infrared and ultraviolet areas
4) electron microscopy and microanalysis have a complex application in parallel to optical microscopy. As an example of more exotic art objects we can name anthropological fragments, assay marks/stamps, etc. [2],
5) FTIR and Raman spectroscopy – especially for identification of organic phases, fibres, etc., FTIR is used in both transmission and reflective mode.
6) XRF and microXRF is used both with taken microsamples and during primary screening of large objects (statues, paintings, sculptures), when areas for more detailed examination are identified
7) XRD and microXRD allow direct phase analysis even with substances that are not chemically distinguishable
8) X-ray imaging – gives valuable information on the object structure, repaint of paintings, brushwork and laying up manner. X-ray tomography might be very useful with some objects, as it enables subsequent 3D model creation.
9) Other methods used - LA-ICP-MS, SIMS, PIXE, synchrotron radiation, which allows performance of a number of standard analyses with sensitivity higher by several orders of magnitude (FTIR, XRF, XRD etc.) [3]

As a practical example we can present the case of fake paintings of an important author from the thirties, Jan Zrzavy, and a contemporary author Kristian Kodet. A total of 60 fakes of Zrzavy and 12 fakes of Kodet were analysed by complex methods. In this concrete case especially microscopic and X-ray methods helped identify the fakes.

References

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