

## **Testing micro-analytical and non-invasive portable instruments for investigation of works of art; from medieval to modern art**

Veronika Košarová

The presentation is divided into three separate researches which connect the infrared and Raman spectroscopy in the field of fine art. First issue is focused on compositional characterization of clay and iron oxide pigments used in the paintings grounds and on application of infrared and Raman spectroscopy and X-ray diffraction methods, second of them discusses application of a handheld FTIR spectrometer with diffuse reflectance and ATR holders for the analysis of painted artworks, last of them the efficiency of Raman micro-spectroscopy in the analysis of complicated mixtures in modern paints by Edvard Munch and František Kupka.

In order to conduct a quality research of a painting it is necessary to describe all layers of a painted artwork (stratigraphic analysis), and supplement the description with a complete material analysis of the layers. However, a work of fine art is a very complicated heterogeneous complex, and in order to interpret an artwork correctly it is important to compare the results of several analytical techniques. Spectroscopic methods, mainly infrared and Raman spectroscopy are nowadays the most frequently used methods in this field, which is principally caused by their easy utilization, non-invasiveness, and a broad range of application, which embraces both organic and inorganic substances. Raman spectroscopy is a sought-after method thanks to its availability and the cost of instruments, and systematic development of new measurement techniques. However, its serious drawback still remains formation of undesirable fluorescent radiation, which is an accompanying phenomenon of measurement in many materials.

The aim of my presentation is therefore to inform you about new applications and development in the field of infrared and Raman spectroscopy for investigation of works of art which is main part of my postgraduate research. The microanalysis of clay minerals (in painted artworks are main components in earthy pigments in ground layer) still has not received sufficient attention, and in many professional publications there were often mentioned false terminological determinations. Moreover, spectroscopic methods have never been compared there with the insufficiently widespread diffraction methods in view of differentiation of various groups of pigments. Handheld instruments became very popular in last years in different application fields, but, in a case of handheld FTIR, only a few studies have been reported yet. The major limits for a routine use still can be seen in a relatively high weight of instruments (getting low contact pressure for to obtain reliable spectra with ATR holder), low penetration causing that the analytical signal is collected from the top surface layer only etc. I used handheld instrument for a distinguishing of paper treatment (e.g. gluing), for the painting technique description in the modern art (watercolour, wax crayon or oil painting). Last but not least, I want to point out limits of Raman micro-spectroscopy to analyse complicated pigment mixtures in modern paints from the period of the turn of the 19<sup>th</sup> and the beginning of the 20<sup>th</sup> century at paints of two of the world-famous modern painter – Edvard Munch and František Kupka.