New Application of Infrared Microscopy and Imaging in Difficult Sample Analysis

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Structural study of complex samples (e.g. microcrystals of zeolites, aerosol particles, archeological materials and biological tissues) using Fourier transform infrared (FTIR) microscopy and imaging will be discussed.

FTIR microscopic study of zeolites with chiral and achiral structures has been performed. Thermal decomposition of organic amines (templates) was monitored on 50-100 μm diameter single crystal particles up to 400 °C by heated sample stage FTIR microscope. The complete removal temperatures have been determined for several $Ge_xSi_{10-x}O_{20}$ zeolite crystals [1].

FTIR microscopy has several advantages compared to traditional analytical methods used in analysis of aerosol samples (no sample preparation need, some 10^{-11} g samples can be investigated non-destructively in a short measurement time). Inorganic ions (SO_4^{2-}, HSO_4^-, NH_4^+, NO_3^-) and even ionic compounds have been determined. The submicron particles contained mostly acetone soluble organic compounds (aliphatic hydrocarbons, organonitrates, carbonyl compounds) and inorganic ions (mostly ammonium sulphate), while the supermicron particles consisted of insoluble bioaerosol (amide, carbohydrate, phosphate) and traces of soil (SiO_2, kaolinite) [2].

FTIR microscopy, due to high lateral resolution (~5 μm) is suitable for homogeneity studies of art objects. Late Neolithic painted ceramics were studied: as red colouring pigment cinnabar was identified for the first time, mixed homogeneously with purified kaolinite [3].

It was firstly demonstrated in our laboratory, that IR spectra of human hair can be correlated with general physiological condition of human body [4]. The strong degradation of hair surface due to UV-irradiation, bleaching agents, etc. cause difficulties in spectral evaluation. Therefore FTIR imaging of cross-section of human hair was carried out. The spatial resolution (~5 μm) will provide several hundreds of spectra characteristic to medulla, cortex and cuticle. We have developed a special program system based on cluster analysis to select important spectra of microtomed hair. The multispectral approach with combination of statistical data processing will provide new and sensitive diagnostic opportunities based on spectral features of non-degraded cortex and medulla.

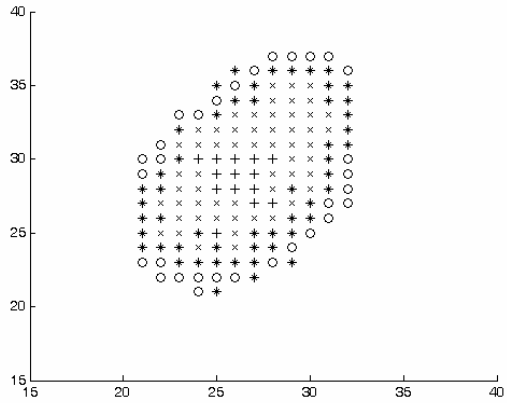

Fig. 1: Transmission FTIR imaging of human hair (4μm). + - medulla, x – cortex, * - slightly degraded cuticle, o – strongly degraded cuticle.

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[3] J. Mihály, V. Komlósi, A. Tóth, Zs. Tóth and G. Ilon, Porceeding of 9th European Meeting on Ancient Ceramics (EMAC), 24-27 Oct. 2007, Budapest, Hungary
[4] An European Patent application procedure is under progress

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