XRS has long been discussed in an important but somewhat limited context, specifically, as a bulk-sensitive alternative to x-ray absorption spectroscopies. However, continuing developments in both experimental apparatus and theoretical methods are steadily opening up new opportunities which are special to the large momentum transfers q which can be accessed in XRS. In this presentation, we will survey a few such recent studies. These will include applications for basic spectroscopy (He gas), environmental and renewable energy (N_2 gas and $LiTiO_x$), exotic chemical bonding ($C_2B_{10}H_{12}$), and f-electron physics (CeO_2 and UO_2).

Keywords: inelastic x-ray scattering, X-ray Raman scattering, electron energy loss spectroscopy

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X-ray Raman of water in the condensed phases

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In-situ measurement of the x-ray Raman spectra on the oxygen K-edge of several forms of ordered and disordered ice will be reported. It is shown there is a significant difference in the absorption profile in the near-edge and post-edge region between crystalline and amorphous ices. Comparisons between observed and theoretical spectra are made. Difficulties in the first-principles calculation of core level absorption spectra will be discussed.

Keywords: X-ray raman, a ray absorption spectroscopy, ice

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High-resolution X-ray Raman scattering and the study of ices under high pressure

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High-resolution x-ray Raman scattering (XRS) of oxygen K-edge in various forms of ices have drawn a great deal of interest recently. The double differential cross section can be shown to provide the same information as that obtained by x-ray absorption spectroscopy (XAS) when the momentum transfer is small enough that the dipole approximation is valid. For low-Z elements whose inner shells are in the soft x-ray region, XRS possesses unique advantages compared to XAS due to its inherent bulk sensitivity and good penetration depth, and is especially valuable for studies under extreme thermodynamic conditions such as high pressure. At a total energy resolution of ~300 meV at 9.89keV, studies on ices III, II, IX, VI and VII at various pressure and temperature conditions indicate that the technique provides clear spectral sensitivity to both short- and long-range structural changes of the H_2O frame work. Our studies, for example, have revealed that a diminishing intensity of the pre-edge feature provides a clear signature of proton ordering in the H_2O frame work [1]. The technique, when coupled with optical Raman and x-ray diffraction, provides also a powerful tool for understanding the chemistry in the disassociation of H_2O induced by the incident x-rays under certain (P, T) conditions [2,3]. Details of these studies will be presented and discussed.

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Keywords: hydrogen bonds, electronic structure, X-ray inelastic scattering

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Nanostructure of ancient Damascus blades

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Legends tell how Damascene blades exhibiting extraordinary properties had been manufactured following secret recipes. During the last decades more sophisticated metallurgical methods have revealed details of the microstructure of this crucible (or wootz) steel. There are indications that impurities and unconventional thermo-mechanical treatments might have an essential influence on the typical Damast pattern. Using scanning and high-resolution transmission electron microscopy, X-ray diffraction as well as micro- and nanohardness measurements we have analysed specimens of two genuine Damascus sabres, which date back to the 17th century. They were kindly left to us by the Historic Museum Berne. Significant new details of the microstructure that have been revealed during our study are nanowires of cementite Fe_3C [1-2] as well as carbon nanotubes ([3] and present work). Moreover, Fe_7C_3 has been detected which is known as catalyst for hydrocarbon synthesis and which eventually converts to Fe_3C [4]. Since carbon nanotubes have become known as forming catalytically from natural fibres [5], this sheds a new light on early reports on the addition of leaves to the crucible [6].

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Keywords: archaeometallurgy, nanophase systems, high-resolution electron microscopy

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Scientific contribution to archaeology: Fingerprinting the ancient Egyptian objects

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Since 1999, scientists and an archaeologist have been working side by side to seek the ancient trade network. Our goal of research is to establish the regional variability of glass and faience in ancient Near East by using the high energy SR-XRF and other methods.