

COHERENCE AND THE ULTIMATE IN ENERGY RESOLUTION

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We report the development of x-ray interferometry based on the coincidence technique. The coincidence counting rate between two output ports of an x-ray interferometer is directly related to the visibilities of the interference fringes. This has been firstly shown using a conventional monolithic x-ray interferometer of triple-Laue type. The advantage of the method is best seen when we adjust a multocrystal component x-ray interferometer. A multocrystal component x-ray interferometer with movable components would pave a way to x-ray Fourier transform spectroscopy. The coincidence technique is applicable to x-ray intensity interferometry that was firstly shown by Hambury-Brown & Twiss using visible light. The chaotic nature of the synchrotron radiation shows the temporal bunching of x-ray photons. Precise measurements of excess coincidence rate give both transversal and longitudinal (temporal) source size. However, this kind of measurement requires longitudinal x-ray coherence length as long as longitudinal source size. For this, we have developed a high resolution x-ray monochromator with 120 μeV at 14.4 keV. Although we used nuclear resonant scattering to determine the energy resolution of the monochromator, the intensity interferometer is applicable to determine the energy width of high-resolution monochromator at arbitrary x-ray energy. We have shown that the intensity interferometer using variable energy width give the longitudinal size of the source, in other words, the pulse width of the source.

Keywords: COHERENCE X-RAY INTERFEROMETER X-RAY OPTICS

THE USE OF SYNCHROTRON AND NEUTRON RADIATION FOR TIME- AND SPACE-RESOLVED POWDER DIFFRACTION STUDIES IN MATERIALS SCIENCE

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The field of Powder Diffraction has been transformed over the last 20-30 years by the arrival of intense penetrating radiation sources, which have enabled time-resolved studies on materials subjected to a wide range of physical/chemical environments. Initially this exploitation was primarily confined to the domain of monochromatic neutron sources but now both white and monochromatic neutron/synchrotron radiation are regularly used in this pursuit. The more recent capability for space-resolving the origin of the diffracted signal is opening the door to more realistic materials science applications where chemical and physical gradients in the sample can be scrutinized. In this lecture the methodologies for such analyses will be outlined and illustrated with several examples: + the reduction of molybdenum trioxide; + the kinetics of zirconia synthesis under autoclave conditions; + zeolite framework transformations following cation exchange and dehydration; + the birth of a zeolite membrane; + the diffusion of cations and pathogens, such as prions, in the environment.

Keywords: MATERIALS NON-AMBIENT SYNCHROTRON

NEW CHALLENGES FOR X-RAY OPTICS

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Future sources will produce hard x-rays with unprecedented optical qualities – typically a combination of high brightness, high spatial coherence, and very short pulse length. Using this radiation to best scientific advantage will place severe demands on the x-ray optics. In fact, there remain unresolved questions about the basic optical properties of materials when subjected to this radiation. Nevertheless, efforts are underway to design optical components for future light sources. This paper will review the considerations affecting these design efforts, and describe some of the strategies that may be employed to manipulate and condition future x-ray beams without degrading their desirable characteristics.

Keywords: X-RAY OPTICS, NEW X-RAY SOURCES, FEL

ULTRA-HIGH SPEED NEUTRON DIFFRACTION STUDIES OF THE COMBUSTION SYNTHESIS OF Ti_3SiC_2 AND RELATED COMPOUNDS

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In-situ neutron diffraction at 0.9s and 0.38s time resolution was used to capture the reaction mechanism during the self-propagating high-temperature synthesis (SHS) of Ti_3SiC_2 from furnace ignited stoichiometric Ti/SiC/C and Ti/Si/C mixtures. The diffraction patterns indicate that the SHS proceeded in five stages: (i) pre-heating of reactants, (ii) the hcp -bcc phase transformation in Ti, (iii) pre-ignition reactions, (iv) the formation of a single solid intermediate phase in approximately 0.5s and (v) rapid precipitation of Ti_3SiC_2 . The hcp -bcc phase transformation in Ti and subsequent reaction of Ti and C are necessary precursors to the SHS. No contribution to the diffraction patterns from a liquid phase was detected, hence it is unlikely that a liquid phase plays a major role in this SHS reaction. The intermediate phase is believed to be a solid solution of Si in TiC, which preserves the overall stoichiometry, (3Ti:1Si:2C). The ignition conditions, reaction rate and combustion temperatures were profoundly influenced by the chosen reactants (SiC vs. Si). Lattice parameters and known thermal expansion data were used to estimate the ignition and combustion temperatures. For example, in the system 3Ti+SiC+C, these were $923 \pm 10^\circ\text{C}$ (supported by the hcp -bcc phase transformation in Ti) and $2320 \pm 50^\circ\text{C}$ respectively. The related compound Ti_3AlC_2 was found to form from Ti/ Al_4C_3 /C mixtures by a related mechanism.

Keywords: SELF PROPAGATING HIGH TEMPERATURE SYNTHESIS, IN-SITU DIFFRACTION, TITANIUM SICILON CARBIDE