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Sub-millimetre-resolved X-ray phase analysis for materials science

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At Structural materials science end-station of Kurchatov synchrotron radiation source the method of sub-millimetre spatial resolved X-ray diffraction is realised. This method allow determining spatial inhomogeneity of phase composition, crystal phase parameters, crystal fraction and pair distribution functions (PDF) with spatial resolution up to 200 mkm. It is implemented in the following routine. Synchrotron radiation monochromased with channel-cut Si(111) or Si(220) monochromator is placed at desired point of transmissive sample and the scattered radiation is recorded by MarCCD165 detector. The sample can be scanned automatically through the beam with desired number of spatial points with control of beam position with stepper motor and optical monitor. Number of point is limited only by desired quality of individual diffraction pattern. In practice 5 minute exposition per point is sufficient for phase analysis and 30 minutes per point for obtaining the PDFs. Once measured 2-D diffraction patterns, they are processed by automated software to reduce them to the 1D patterns, fit to desired crystal phase composition model and determine crystal phase parameters or with pdfgetx3 software [1] to get PDFs.
This method is used for structural investigation of Ti50Ni25Cu25 metallic glasses subjected to severe plastic deformation by Bridgeman cell. This material is characterised by crystallisation-amortisation cycle upon such processing [2]. The utilisation of the new method allowed us to determine spatial inhomogeneity of this phase transition and to follow this process depending on initial state of material and thermodynamic parameters, namely pressure and temperature, of plastic deformation.

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