HIGH-PRESSURE X-RAY DIFFRACTION TECHNIQUES: APPLICATION TO DETERMINATION OF THE EQUATION OF STATE OF SELECTED MULTICOMPONENT OXIDES

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High-pressure diffraction techniques developed in the first half of 20^{th} century thanks to, in particular, the work of Nobel laureate (1946), P.W. Bridgman. These techniques exploit pressure cells of various types. Pressure cells and the materials they are built from must fulfill specific constraints in order to optimize the diffraction-pattern quality. The degree of difficulty grows with increasing the required pressure value. The highest static pressures (of the order of 300-400 GPa) accompanied by temperatures from several K to 6000-7000 K can be attained using diamond anvil cells, constructed fifty years ago at NIST (USA) by C.E. Weir [1] and then applied for X-ray diffraction studies [2].

One of challenges is getting the diffraction signal from an extremely small powder sample (down to 5 μm). This is possible at modern synchrotron-radiation sources providing intense collimated beams, whereas at classical laboratories, experiments have a practical pressure limit of several tens of GPa.

High-pressure diffraction studies constitute the main approach used for determination of pressure-phase transitions, equations of state and completing the phase diagrams by the pressure variable. They are useful in understanding the nature and in design of materials, as well as in modeling the earth and planet interior at depths that are inaccessible to direct studies. In the present talk, the basic devices and techniques used in high-pressure studies will be described, and examples of recent results for selected multicomponent oxides will be described.

References

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[2] J.C. Jamieson, A.W. Lawson, N.D. Nachtrieb, Rev. Sci. Instrum. **30** (1959) 1016.