XRD to study plasticity in nanocrystalline materials

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X-ray diffraction (XRD) has been used for a century to study the effects of cold working on polycrystalline materials. A long-standing debate began in the 1920s about the origin of the broadening of diffraction peaks in work-hardened metals, whether it can be interpreted as a microstress effect or fragmentation of crystal grains. The need to distinguish between these two mechanisms was the driving force in the development of the line profile analysis (LPA) methods we still use today, based largely on the seminal works of A.R. Stokes & A.J.C. Wilson, M.F. Bertaut, B.E. Warren, M.A. Krivoglaz and M. Wilkens of the last century. Over the years, a vast body of experimental studies has accumulated, on both metals and ceramics, demonstrating how the analysis of diffraction peak broadening can contribute to the study of plasticity. Evidence provided via LPA usually contributes to the study of microstructural effects, while the actual measurement of properties is usually performed with mechanical tests – tensile, impact, and hardness, to name a few.
This contribution presents the state of the art of LPA applied to nanocrystalline and highly deformed materials. It discusses the information that can be obtained via LPA in these cases, where traditional mechanical tests are not always feasible. The presentation also illustrates the advantage of using a reference material, both to calibrate experimental and analytical methods and to better understand the effects of plasticity at the nanoscale [1].

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