Energy dispersive X-ray diffraction in laboratory conditions using 2D photon counting detector

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Traditionally the X-ray diffraction (XRD) has been implemented using angle dispersive approach where a monochromatic beam irradiates the sample and diffraction pattern is measured as a function of scattering angle. This approach is typically followed by long acquisition time, and limited penetration depth when dealing with thick or highly absorptive samples. These limitations can be overcome by using energy dispersive XRD (EDXRD). In this approach, XRD pattern is measured as a function of incident photon energy instead of a scattering angle. By varying the incident photon wavelength, larger portion of reciprocal space is recorded without the need for an angular scanning. Furthermore, higher incident beam energies provide lower absorption and higher penetration depths.

So far, EDXRD has mostly been a domain of large synchrotron facilities where the wavelength of high-flux, high-brilliance beam can be varied in a broad energy range. In laboratories, where conventional X-ray tungsten/molybdenum/silver anode is used as a source of polychromatic radiation, 0D HPGe [1] or SDD [2] detector are used to detect the EDXRD spectrum at a fixed angle. In recent years, the emergence of 2D photon counting detectors, where both position and energy of each individual photon is measured simultaneously, allows for EDXRD experiments in laboratory conditions with greatly reduced acquisition times. In this work, EDXRD capabilities using 2D photon counting detector based on a TimePix3 readout chip will be presented. It's ultra-high dynamic range, near zero dead time, intrinsically low background and ability to filter cosmic radiation are crucial in XRD measurements. Energy resolution will be compared for a different sensor chip materials. Finally, in-situ measurements of low-carbon steel phase transformation [3] and other potential industrial applications of this method will be shown.

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