Contribution of Numerical Simulation to Stress Evaluation by Neutron or Synchrotron Diffraction

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As demonstrated by various round robin tests, stress evaluation by neutron diffraction or synchrotron radiation is reliable when the probe volume is completely immersed in the studied material. However, near surface measurements or acquisitions carried out close to interfaces are much more difficult to analyze, due to parasitic shifts of the diffraction peaks which are obtained in such condition.

This study shows the contribution of numerical simulations to solve this problem. It demonstrates that a complete modeling of diffractometers by a Monte Carlo method allows defining precisely the size and shape of the probe used. It permits then predicting the evolution of the diffracted intensity versus the position of this volume in the matter. This approach allows also determining and correcting all systematic shifts of the diffraction peaks which appear when measurements are carried out near the surface or close to an interface. The calculations finally let to define the real analyzed depth, accounting for the local conditions of diffraction and absorption in the material. The experimental procedures implemented thanks to the numerical simulations strongly improve the space resolution of the neutron and synchrotron stress evaluation methods and reduce the uncertainties of the results. To this last end a new method for a global analysis of stress fields was developed which greatly improves the precision of measurements.

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