Residual Stress Measurement of Polyethylene Pipes with Two-Dimensional X-Ray Diffraction

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The residual stress measurement based on the X-ray diffraction takes the advantage of non-destructive and direction method and it can tell the principle stress of any interested point, which is critical for the material failure. However, this method has been widely used only on metal materials which have high diffraction angle. In this work, a method for measuring residual stress of high density polyethylene pipes with two-dimensional X-ray diffraction is proposed. This method utilizes two-dimensional detector to collect data of a selected diffraction ring and rotates sample with only one psi-tilt angle 22.5° and phi scan covers 0°～360° with 45° intervals. The diffraction ring of ca. 36° 2θ angle, which corresponds to (020) lattice plane was selected for stress analysis due to its relative high diffraction angle and being less overlapped with neighbor diffraction peaks for polyethylene. The stress calculation was done with Bruker DIFFRAC.LEPTOS software. The stress-free corundum powder sample was used to check the system error.

The distribution of residual stress on the surface of high density polyethylene pipes was obtained. The results indicate that a small tensile stress is shown in the pipe extrusion direction, while a relative large compressive stress is shown in the hoop (circumferential) direction. The residual hoop stress plays an important role in the pipe lifetime.

The stress measurement by two-dimensional X-ray diffraction shows the potential application in semi-crystalline polymer materials.

References:

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