

## **RESIDUAL STRESSES IN COLD-DRAWN RODS: EFFECT OF AN ALTERNATIVE TREATMENT**

J. Ruiz-Hervias<sup>1</sup>, M. Hofmann<sup>2</sup>, J. Rebelo-Kornmeier<sup>2</sup>, V. Luzin<sup>3</sup>, and M. Elices<sup>1</sup>

<sup>1</sup>Dpto. Ciencia Materiales, UPM, Profesor Aranguren, s/n, E-28040 Madrid, Spain

<sup>2</sup>FRM-II, TU München, Lichtenbergstr. 1, D-85747 Garching, Germany

<sup>3</sup>Bragg Institute, ANSTO, MENAI NSW 2234, Australia

Cold-drawn steel wires and rods are widely used in industry, i.e. for tyre (very thin wires) and concrete reinforcement (wires and rods). The fabrication process (cold-drawing) consists of pulling the wire through a conical die to reduce its diameter. Several steps are usually employed to achieve a large section reduction. The material deformation during the process is quite inhomogenous. Consequently, residual stresses are generated in the wires.

Wire manufacturers are aware of the problem and try to alleviate residual stresses by means of in-line post-drawing thermomechanical treatments. These treatments involve stretching the wire to a certain deformation at a moderate temperature. Other alternatives have been proposed, for example to subject the wires to a final drawing step with a very small section reduction (termed “skin pass”). However, its effectiveness in terms of residual stress reduction has not been assessed yet.

In this work, samples of single phase (ferrite) and two-phase (pearlite) steel rods were studied. Both were subjected to one drawing pass and some samples were given a second drawing pass with only a 1% section reduction (“skin pass”). Through-thickness residual strain profiles were measured by neutron diffraction in the ferrite phase along the three principal directions of the rods, namely radial, hoop and axial. Measurements were performed in the strain scanner StressSpec (FRM-II, Garching, Germany). The reference lattice spacing was measured in “comb-like” specimens fabricated by EDM.

The experimental data are very good, with narrow diffraction peaks and very low background. A significant residual stress development was found in the samples subjected to one drawing step, with compressive residual stresses at the rod center and tensile ones at the surface (especially the hoop and axial components). Stress balance is approximately fulfilled in the single phase (ferrite) rods. However, in the two-phase (pearlite) rods, the residual stress profiles are clearly unbalanced because the stresses in the second phase (cementite) could not be accounted for. The “skin pass” step produces a considerable reduction of the residual stresses, which makes it an interesting alternative to existing post-drawing treatments.