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Experimental Characterizing Size Effects of Micro-Diameter Copper Wires on Torsion Plasticity

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Attention has been paid to size effects on the strength of materials when developing plasticity, strain gradient, as well as dislocation theories. Modeling the size effects significantly depends on accurate experimental data, which calls for inventing reliable experimental methodology. Quasi-static torsion experiments have been conducted on micro-diameter wires to investigate size effects on plasticity. However, current commercial torque cells are not capable of measuring very small amplitude of torque needed to deform the micro-diameter wires in torsion. Recently developed indirect measurement methods may also not be sufficiently reliable, producing inconsistent size effects in torsion for the micro-diameter copper wires. A direct small torque measurement has been developed at Sandia National Laboratories, CA, enabling to measure the small torque applied to the copper wires with different diameters. This technique is also capable of precise control of the rotation rate applied to the micro-diameter wires such that strain-rate effects are able to be either determined or easily removed from size effects. This technique was employed to conduct torsion experiments on copper wires with different sizes. No significant size effect was observed in the copper wires used in this study.

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