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Tuning the Electro-Optical Properties of Nanowire Networks

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Conductive and transparent metallic nanowire networks are regarded as promising alternatives to Indium-Tin-Oxides (ITOs) in emerging flexible next-generation technologies due to its prominent optoelectronic properties and low-cost fabrication. The performance of such systems closely relies on many geometrical, physical, and intrinsic properties of the nanowire materials as well as the device-layout. Adequate comprehensive computational study is essential to make any device fabrication cost-effective. Here, we present a computational toolkit that exploits the electro-optical specifications of distinct device-layouts, namely standard random nanowire network and transparent mesh pattern structures. The target materials for transparent conducting electrodes of this study are aluminum, gold and silver nanowires. We have examined a variety of tunable parameters including network area fraction (AF), length to diameter aspect ratio (AR), and nanowires angular orientations under different device designs. Moreover, the optical extinction efficiency factors of each material are estimated by two approaches: Mie light scattering theory and finite element method (FEM) algorithm implemented in COMSOL® Multiphysics software. We studied various nanowire network structures and calculated their respective figures of merit (optical transmittance versus sheet resistance) from which insights on the design of next-generation transparent conductor devices can be inferred.

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