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Tuning electrical properties of hierarchically assembled Al-doped ZnO nanoforests by room temperature Pulsed Laser Deposition

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Large surface area, 3D structured transparent electrodes with effective light management capability may represent a key component in the development of new generation optoelectronic and energy harvesting devices. We present an approach to obtain forest-like nanoporous/hierarchical Al-doped ZnO conducting layers with tunable transparency and light scattering properties, by means of room temperature Pulsed Laser Deposition in a mixed Ar:O_2 atmosphere. The composition of the background atmosphere during deposition can be varied to modify stoichiometry-related defects, and therefore achieve control of electrical and optical properties, while the total background pressure controls the material morphology at the nano- and mesoscale and thus the light scattering properties. This approach allows to tune electrical resistivity over a very wide range ($10^{-1} - 10^{6}\,\Omega$ cm), both in the in-plane and cross-plane directions. Optical transparency and haze can also be tuned by varying the stoichiometry and thickness of the nano-forests.