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Mechanical and wetting properties of three-dimensional flexible tetrapodal ZnO networks ALD-Coated with Al2O3

Abstract

Nano- and microscale tetrapodal shaped ZnO particles (T-ZnO) are considered to be truly multi-functional and have a tremendous potential for a large variety of applications ranging

from gas/vapor sensors to biomedical implants. In this approach highly porous interconnected networks were formed from T-ZnO particles produced by the versatile flame transport synthesis (FTS) at Kiel University and coated by Al2O3 with different film thicknesses by atomic layer deposition (ALD) technique. Presence of Al2O3 inside the network was confirmed by the energy-dispersive X-ray spectroscopy (EDX). Compression tests showed that with increasing Al2O3 coating thickness mechanical properties were significantly improved, e.g. the Young's modulus of networks with a T-ZnO density of 0.5 g/cm3 was raised from 1.0 ± 0.3 MPa (pure T-ZnO) to 1.80 ± 0.2 MPa when coated with 60 nm Al2O3, whereby the elastic limit (yield strength) was increased by a factor of two as well. Contact angle (CA) measurements revealed that switching of wetting properties from super hydrophilic (water droplet is rapidly sucked into the network) to super hydrophobic (water droplet lies on the surface with CA = 142° ± 2°) is possible depending on the hydration state of Al2O3. The successful combination of T-ZnO and Al2O3 can further broaden the application range of T-ZnO particles, e.g. for humidity detection as well as in the field of bio-electronic devices.