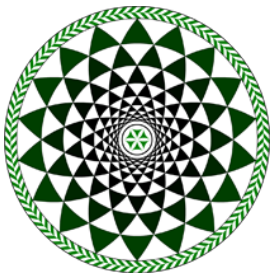

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Nanoporous Al_2O_3 templates: a route towards flexible humidity sensors with linear response

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Nanoporous and nanotubular anodic oxides of valve metals (Al, Ti, W, Ta etc.) possess larger surface area with more reaction sites and more developed surface morphology than flat materials. These unique properties of the templates are used to address their technological applications in different types of sensors. For example, capacitance of porous oxides is sensitive to air humidity and allows their use as humidity sensors. Furthermore, fabrication of porous anodic oxides on flexible kapton foil provides an unique possibility to adjust the shape of the sensor and affords significant advantages over the conventional rigid sensors.

The main objective of the work is to determine optimal morphology (pore diameter and interpore distance) and thickness of flexible Al_2O_3 which provide the largest linear response. For these purpose we produced a series of rigid Al_2O_3 samples with various pore diameters (D_{P} ∼30-270 nm), interpore distances ($D_{\mathrm{IN}} \sim$ 65-420 nm) and thicknesses ($t \sim$ 0.250 μm - 1 μm) by anodization of thick Al foil. In order to investigate sensor response of the samples we measured impedance sensitivity to air humidity at four working frequencies of 100 Hz, 500 Hz, 1 kHz and 10 kHz, and the largest impedance sensitivity was found for the frequency of 1 kHz. The samples exhibited exponential electrical response with the largest impedance changes for high humidity (from 70% to 100%). The best performance was achieved for sensor with D_{P} ∼47 nm, $D_{\mathrm{IN}} \sim$ 96 nm and $t \sim$ 0.5 μm. In order to get the linear response of the sensor the sample was modified by boiling in water for 100 minutes. This modification resulted in linear electrical response of the sample, however, the sensor sensitivity decreased 100 times.

Then we fabricated the sample with the same structural parameters as mentioned above on flexible kapton foil. The sample on flexible substrate showed a linear response with larger impedance sensitivity than for the sample prepared on aluminium foil.
The results have shown the potential of future application of flexible porous Al_2O_3 coatings as humidity sensors.

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