VANADIUM OXIDE NANOSTRUCTURES AS SELECTIVE AND SENSITIVE GAS DETECTOR MATERIAL FOR REDUCTION OF NO_X EMISSIONS

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An excimer XeCl laser with wavelength of $\lambda = 308$ nm, pulse duration of t = 25 ns, and repetition rate of f = 10 Hz was used to prepare V_2O_5 nanostructures from ceramic V_2O_5 pellet by pulsed laser deposition (PLD). The laser pulse energy density on the target surface was 1.75 J/cm^2 and the oxygen partial pressure in the deposition chamber was varied between $p(O_2) = 0.04$ mbar $p(O_2) = 0.4$ mbar. All the depositions were made at RT on oxidized silicon substrates. The films were post-annealed in a furnace at 400 °C in air atmosphere for 1 h period. Platinum electrodes with titanium serving as adhesion layer were deposited by RF-sputtering for electrical measurements. The crystal and microstructures of the films were confirmed by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, atomic force microscopy (AFM), and scanning electron microscopy (SEM).

The crystal structure was determined to be pure orthorhombic V_2O_5. A clear variation in the structures between denser films and extremely porous nanoparticle agglomerates was identified. In the inset of Figure 1, a cross-section SEM micrograph of one particular V_2O_5 layer deposited at $p(O_2) = 0.2$ mbar is presented. This layer is consisting of about 150 nm long and 50 nm wide nanostructures with pillar-like growth-mode. All the films could detect ammonia gas down to few ppm-levels and were also extremely selective to NH_3 compared to NO and CO gases. Figure 1 shows a clear reducing response to 20 ppm of ammonia gas, seen in the purple curve as decrease in electrical resistance, even in the presence of 100 ppm of CO and 20 ppm of NO in the background. Furthermore, the response to NO gas is almost negligible. These nanostructures are very promising candidates to control urea injection in Selective Catalytic Reduction (SCR) process used in combustion engines to reduce the amount of NO_x emissions in their exhaust. In order to control this process more reliably, a sensitive and selective NH_3 gas sensor is needed.

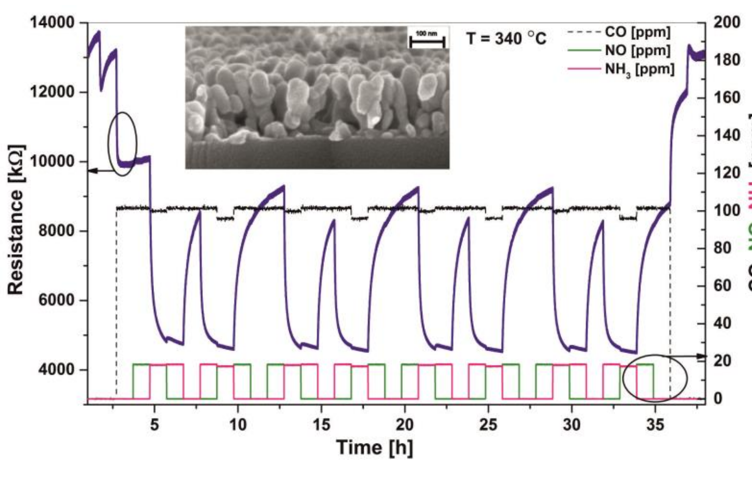

Figure 1: Sensor response and SEM micrograph (scale bar 100 nm) of a V_2O_5 sensor layer.