# Preparation of nanocrystalline $Co_3O_4$ powder and processing of thick films for sensor application

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Cobalt oxide, $Co_3O_4$, which is known as a good CO catalyst, has in the past decade also drawn some research interest as a p-type metal oxide gas sensor. A powerful strategy to improve the sensor performance is the utilization of a nanocrystalline powder with a high surface to volume ratio. Thus, a strong interaction between the surrounding gas and the sensor material is enabled.

The nanocrystalline $Co_3O_4$ powder was synthesised by the nitrate-glycine self-sustained combustion route. The glycine/metal ion ratio was adjusted to provide stoichiometric or fuel-lean conditions of the redox reaction. During the rapid heating, the gels auto-ignited at approximately 250 $^oC$ (depending on the amount of the fuel) and spontaneously underwent a smouldering combustion with the evolution of large amounts of gases, subsequently forming a voluminous precursor powder. According to the X-ray diffraction analysis the phase-pure $Co_3O_4$ was obtained only when the precursor powder was prepared from the fuel-lean redox reaction. The field emission scanning electron micrographs revealed the spongy aspect of the calcined powder, where small primary particles formed the agglomerates.

For the screen-printing, the $Co_3O_4$ powder was milled to break the agglomerates, and then mixed with the organic binder to achieve a viscous paste suitable for printing. The paste was screen printed onto $Al_2O_3$ substrates with interdigitated Pt electrodes for read-out of the resistance and a Pt heater for operation at well controlled temperatures, on the front and back-sides respectively. The about 50 μm thick films were fired at 400 $^oC$ in air. The phase composition was analysed by X-ray diffraction analysis and Fourier transformed infrared spectroscopy. The catalytic conversion of the $Co_3O_4$ powder and the sensor signal of the corresponding sensors were checked under different concentrations of the CO, $CH_4$ and $C_2H_5OH$ test gases.