

## A New Family of Electrochemical Cells for NO Decomposition

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In recent years an intense research effort has been focused on electrochemical cells for reduction of NO<sub>x</sub> gases due to the need to design an effective method for the purification of the exhaust gas from lean burn and diesel engines [1-2]. In present work a new family of electrochemical cells ((Composite working electrode)|Pt(Cathode)|YSZ|Pt(Anode)) for NO decomposition in the presence of excess oxygen were designed and investigated. It was shown that by the control of the microstructure and of the composition of the (NiO)<sub>x</sub>-(YSZ)<sub>1-x</sub> working electrode it was possible to minimize the values of the cell operating current and voltage.

Measurements of the NO decomposition by an electrochemical cells with mixed oxide electrode sintered at temperatures of 1300°C, 1350°C, 1400°C and 1450°C are represented in Fig.1. From this figure it is seen that the process of NO decomposition depends drastically on the working electrode sintered temperature. Our investigations has shown that the increase of the mixed oxide sintering temperature leads to the decrease of the size of the pores from 0.5μ-1μ for working oxide sintered at 1300°C to 30-50nm for the mixed oxide electrode sintered at 1450°C. It was shown that the dependence of the NO conversion on the value of the current passed through the electrochemical cell with a nano-porous (NiO)<sub>x</sub>-(YSZ)<sub>1-x</sub> working electrode is linear, and that the value of current efficiency depended on the NO and O<sub>2</sub> gas concentrations only ( $\eta = [\text{NO}]/([\text{NO}]+2[\text{O}_2])$ ). The development of a new family of electrochemical cells with nano-porous working electrode give us the possibility to minimize the value of electrical current required for NO decomposition and as a result to decrease by at least a factor of 3 the value of electrical power required for NO decomposition.

To reduce more the value of electrical power, the ambipolar transport properties of the composite working electrode and the electrochemical properties of an electrochemical cell for NO decomposition were investigated and correlated with the compositions of the (NiO)<sub>x</sub>-(YSZ)<sub>1-x</sub> working electrode using the most widely used effective medium percolation theory (EMPT). Investigations of the NO conversion rate on the value of voltage applied to the cell has shown a strong dependence of the efficiency of NO decomposition on the composition of mixed working electrodes. To investigate this behavior in detail we have plotted the NO conversion rate as a function of the volume content of NiO in the NiO-YSZ composite electrode for different values of the electrochemical cell operating voltage (Fig.2). From Fig.2 it is seen that the highest efficiency of NO decomposition can be reached where the volume fraction of the NiO phase is within 1/3-2/3 and when the ambipolar conductivity of the composite working electrode should have a maximum value. The optimum NiO addition (35% by volume) to the YSZ resulted in a decrease of the cell operating voltage and in a decrease in the electrical power required for NO decomposition. A mechanism of NO decomposition by this new type of the electrochemical cell with composite working electrode was proposed and investigated.

1. S.Bredikhin, K.Maeda and M.Awano, *Solid State Ionics* **144**, 1-9, (2001)

2. S.Bredikhin, K.Maeda and M.Awano, *Journal of the Electrochemical Society* **148**, (10), D133-D138, (2001)

Fig.1 The dependence of NO conversion on the value of the current for the electrochemical cells with working electrode sintered at temperatures of 1300, 1350, 1400 and 1450°C.

Fig.2 The dependence of NO conversion on the volume fraction of NiO in YSZ for different values of the cell operating voltage.

