Abstract: This study displays the results obtained with a planar, impedance- metric sensor having a NiCr2O4- SE and a specially manufactured FSZ electrolyte. The sensing characteristics to NO and to O2/NO-gas mixtures were analyzed at temperatures up to 700 °C. The cross-selectivity to other flue-gases was tested. As a new capable type of sensing parameter the total impedance was applied.

Keywords: Mixed Oxide Sensing Electrode, High temperature flue gas sensor, Impedance
mixture. The Nyquist-plots of the complex impedance showed good variations by NO concentration in the lower frequency range, which presumably belongs to the electrode-electrolyte phase of the spectrum. The high frequency range, belonging to the bulk resistance of the electrolyte shows no change with NO-variation (Fig.2).

As shown in Fig.2, the real part of the complex resistance decreases with NO-concentration between 0 and 1000 ppm at 620°C. In order to determine the effect of the electrolyte and the Pt-electrode/Pt-current-collector in the spectra, the systems Pt/FSZ/Pt and Pt+spinel-SE/Al2O3/Pt were also analysed by means of impedance spectroscopy. NO was varied from 0 to 1000 ppm. Both systems were hardly affected by the concentration changes.

Mobile applications require simple and low cost sensor systems and it is undesirable to measure the complex resistance in such a system. So we chose to measure the total impedance $|Z|$ at a fixed frequency. As a good compromise of reaction time and sensitivity of the sensor, we fixed it at 0.1 Hz and plotted the total impedance versus concentration of NO [6]. For practical applications, the sensing behaviour in a gas mixture is one of the most critical and important characteristics. Therefore tests were preformed in a mixed base-gas (5 vol.% O2 and Ar) and various concentrations of NO. In contrast to Fig.2 where the Nyquist-plot is used as sensor signal, in Fig.3 $|Z|$ is applied as signal for the NO-concentration. The sensor signal shows a remarkable change with the variation of NO-concentration at 600°C. Regarding these results, it can be postulated that Ni based spinel-SEs could be good candidates for SEs in planar flue-gas sensors at high temperatures. In order to determine the applicability of the sensor, the cross-selectivity towards other combustible gases like O2, CO, CO2 and CH4 were also analysed. The sensors showed a slight but visible change in sensing signal for both oxidizing and reducing gases.

To identify the spinel-SE relevant parts in the impedance plot, some experiments with NO and O2 were carried out on the systems Pt/FSZ/Pt and Pt+spinel-SE/Al2O3/Pt, confirming that the changes in the spectra are mainly caused by concentration changes. In order to fit the spectra, we applied an equivalent circuit with four elements (Fig.4).

Here changes mainly occur in the fourth element which can be attributed to the three-phase boundary electrolyte/spinel-SE/gas [7]. A more detailed analysis showed major changes in the constant phase element. This element can be most likely due to phase change between electrode and electrolyte which may be caused by the catalytic reaction of NO over the spinel-SE.

This study shows the potential of Ni-based spinel-SE impedance-metric sensors as high temperature NOx sensors for use in exhaust gas applications and harsh environments and the applicability of total impedance as a reliable sensor signal.

REFERENCES