

# Effects of Humidity in Cathode Air on LSM/YSZ Cathodes

John S. Hardy, Jared W. Templeton, and Jeffrey W. Stevenson



Pacific Northwest  
NATIONAL LABORATORY

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## Objective

Investigate the effects of 3% Humidity on LSM/YSZ Cathodes at

- Temperature = 800, 850, 900, and 950°C
- Constant Current with Operating Voltage ~ 700 and 800 mV

## Method

Button Cell Measurements of

- Current
- Voltage
- Intermittent Electrochemical Impedance Spectroscopy (EIS)

Cathode air was alternated between dry & 3% moist at ~100 hour intervals

EIS was analyzed using Analysis of Difference in Impedance Spectra (ADIS)

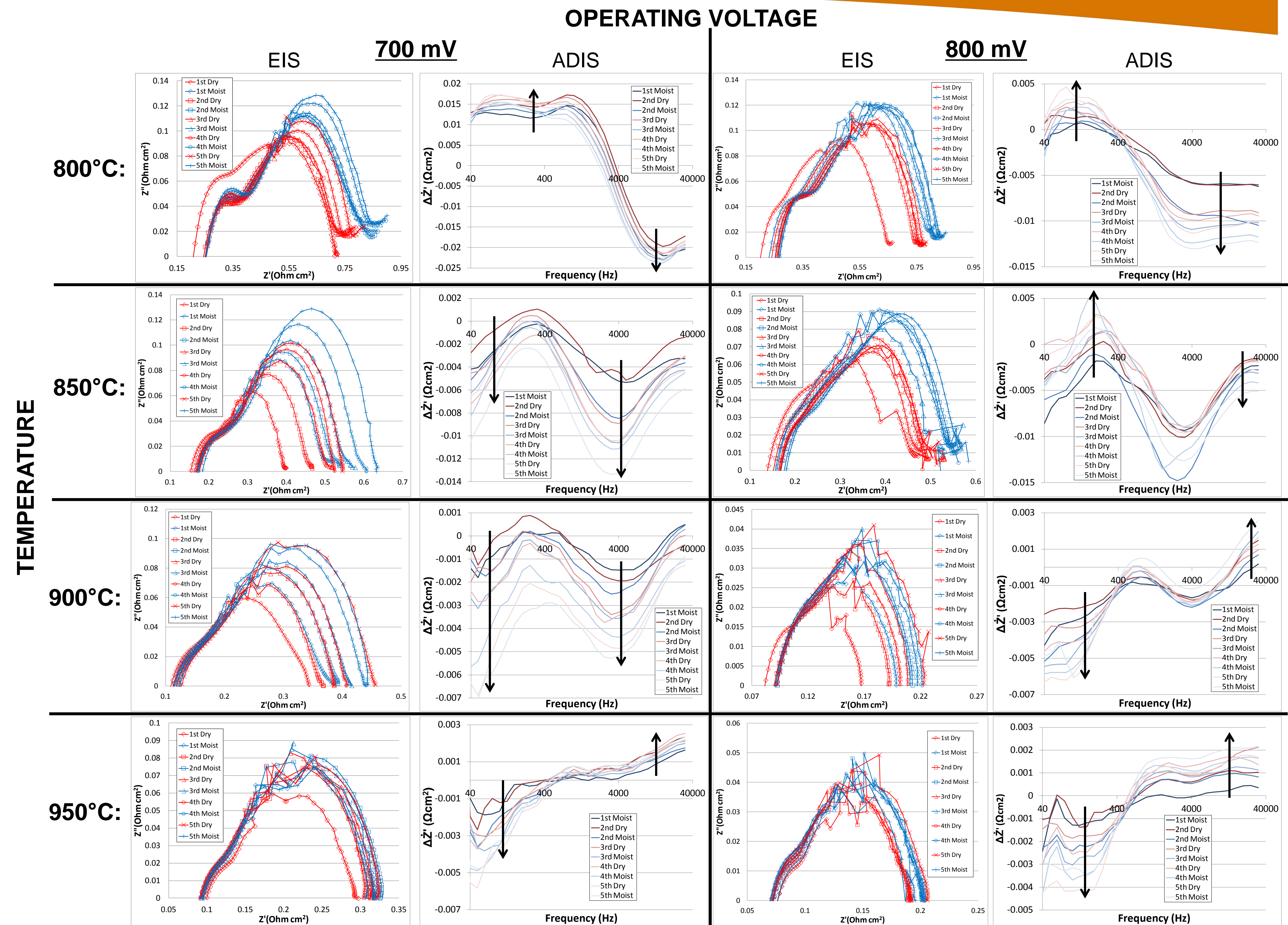
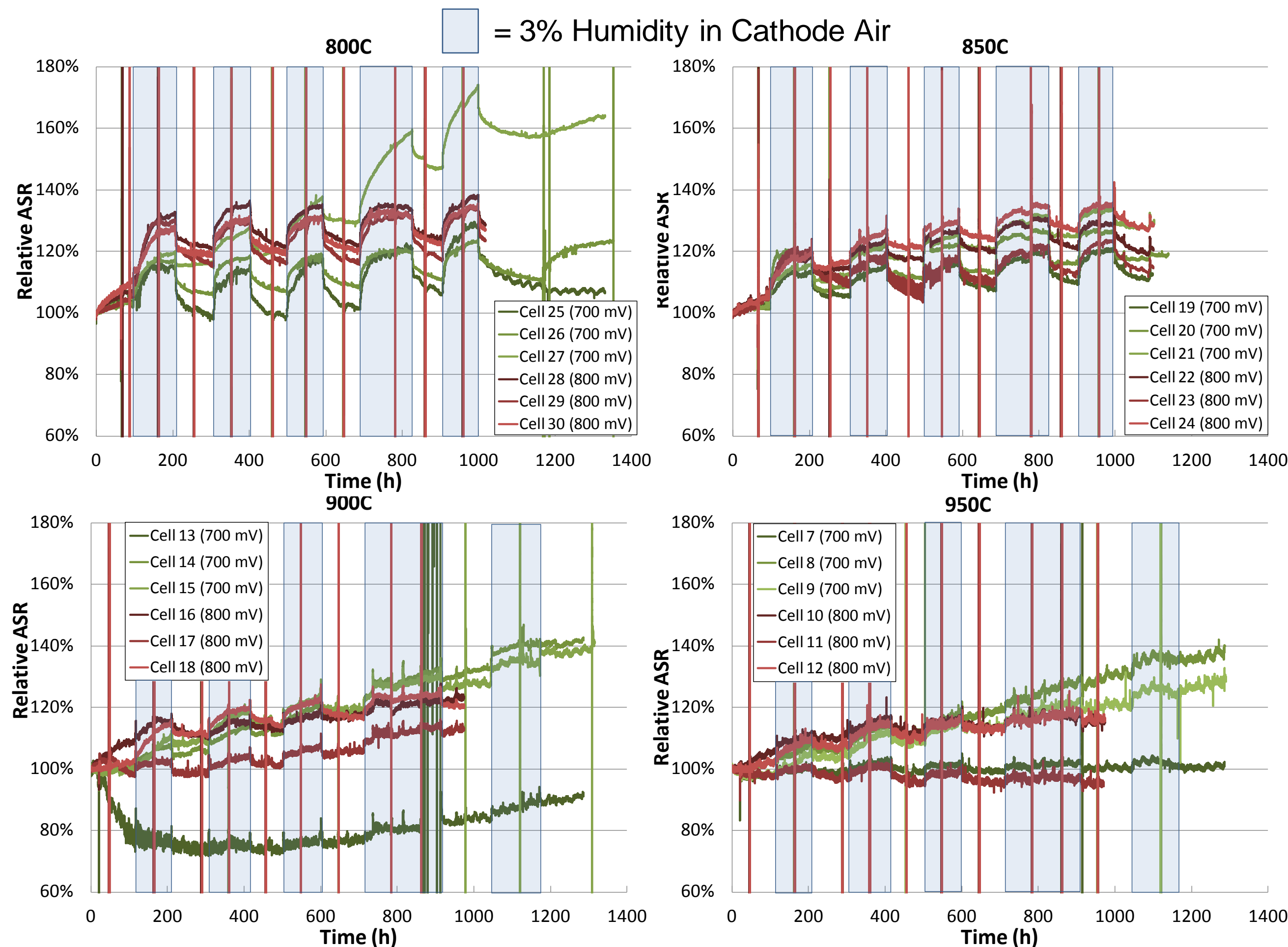
[S.H. Jensen, et al., J. Electrochem. Soc., 154(12) B1325 (2007)]

- ADIS ( $\Delta Z'$ ) helps identify effects of changing test parameters on EIS

$$\Delta Z'(\omega_n) \cong \frac{[Z'_B(\omega_{n+1}) - Z'_B(\omega_{n-1})] - [Z'_A(\omega_{n+1}) - Z'_A(\omega_{n-1})]}{\ln(\omega_{n+1}) - \ln(\omega_{n-1})}$$

- $Z'_A$  and  $Z'_B$  are the real portions of EIS under the original and altered test condition, respectively
- $\omega$  is the frequency at which the EIS data was collected

## Relative Changes in ASR from Initial Values during Humidity Cycling



## SUMMARY

### ASR

3% Humidity causes degradation in performance that is:

- Not dependent on operating voltage at 0.7 – 0.8V
- More pronounced at lower temperature
- At least partially reversible

### EIS

- Ohmic: Increased with time or humidity in most tests below 950°C,
- Polarization: Generally increased in humidity with partial reversal in dry air

### ADIS

- Systematic changes in the ~10<sup>2</sup> and 10<sup>4</sup> Hz frequency range were attributed to phase modification and Mn surface diffusion resulting from LSM decomposition in 750°C tests by Nielsen, et al. [Solid State Ionics 189 (2011) 74].
- Present results suggest the same mechanism at 800-950°C.