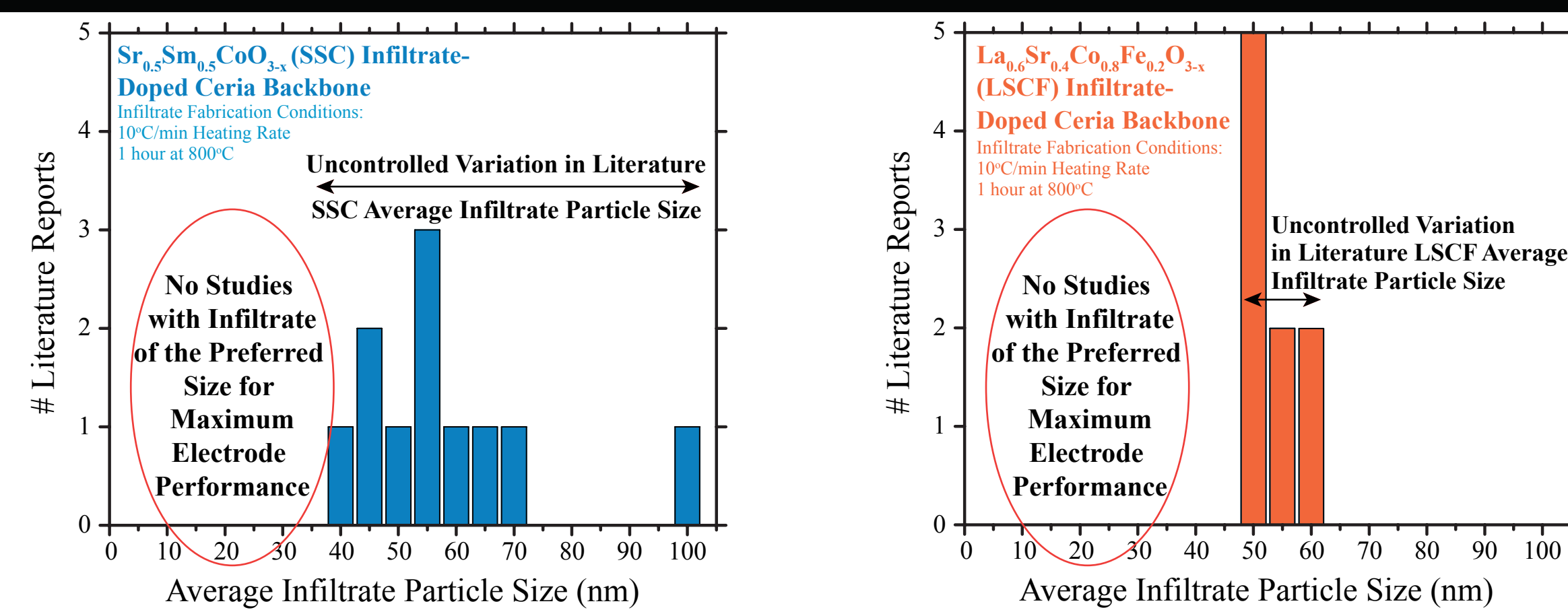


1. Motivation

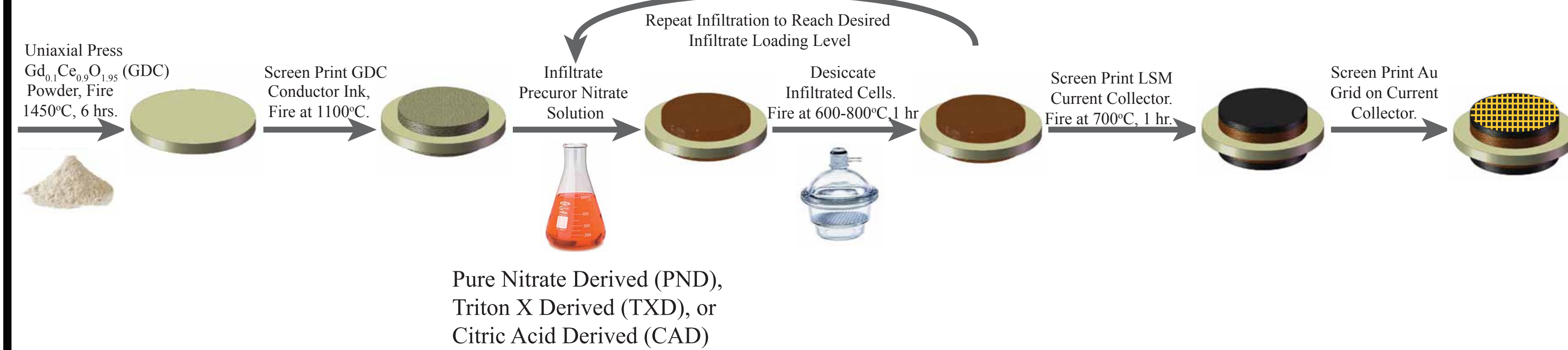
- Past literature studies [1-4] have been unable to control infiltrate particle size, even for identical materials processed under identical synthesis conditions.
- SOFC infiltrate particles with average particle sizes less than ~40 nm have been difficult to produce.



- Nicholas, JD, Barnett, SA. Measurements and Modeling of $\text{Sm}_{0.5}\text{Sr}_{0.5}\text{Co}_{0.5}\text{-Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{1.95}$ SOFC Cathodes Produced Using Infiltrate Solution Additives. Journal of the Electrochemical Society 2010; 157: B536-B541.
- Nicholas, JD, Wang, L, Call, AV, Barnett, SA. Use of the Simple Infiltration Microstructure Polarization Loss Estimation (SIMPLE) Model to Predict the Measured Polarization Resistance of Infiltrated Nano-Composite Solid Oxide Fuel Cell Cathodes. Physical Chemistry Chemical Physics 2012; 14: 15379-15392.
- Zhang, H, Zhao, F, Chen, FL, Xia, CR. Nano-structured $\text{Sm}_{0.5}\text{Sr}_{0.5}\text{CoO}_{3-d}$ Electrodes for Intermediate-temperature SOFCs with Zirconia Electrolytes. Solid State Ionics 2011; 192: 591-594.
- Shah, M, Voorhees, PW, Barnett, SA. Time-dependent performance changes in LSCF-infiltrated SOFC cathodes: The role of nano-particle coarsening. Solid State Ionics 2011; 187: 64-67.

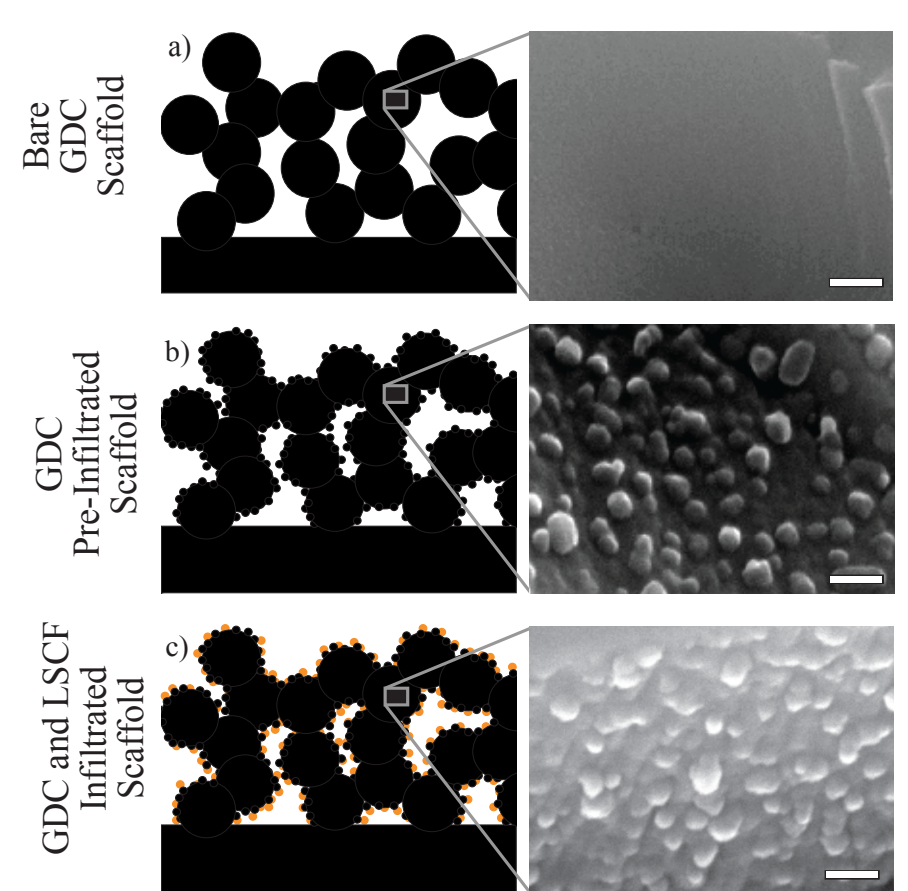
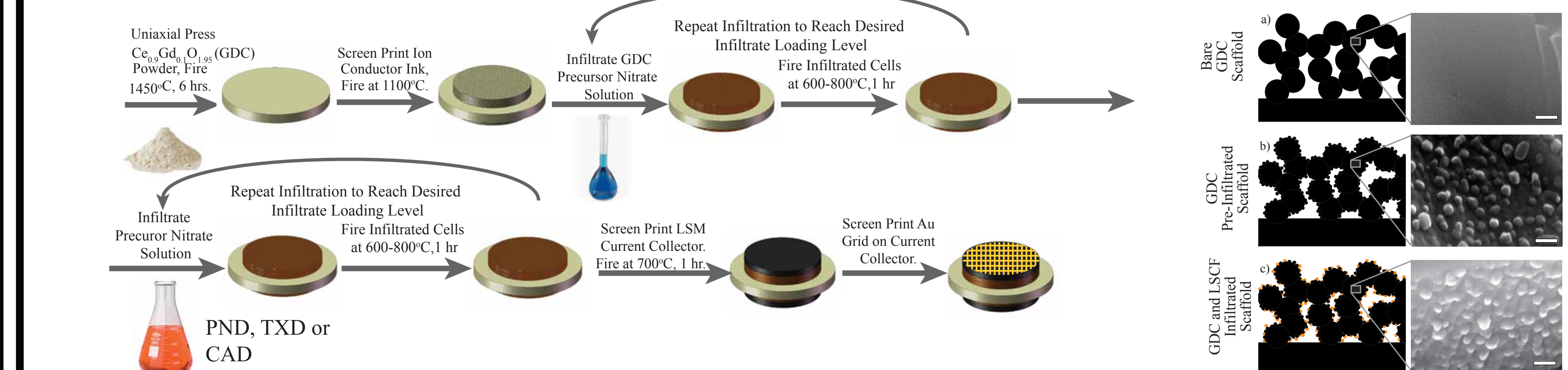
GDC = $\text{Gd}_{0.1}\text{Ce}_{0.9}\text{O}_{1.95}$ CAD = Citric Acid Derived LSM = $\text{La}_{0.6}\text{Sr}_{0.4}\text{MnO}_{3.6}$ PND = Pure Nitrate Derived
 LSCF = $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ce}_{0.8}\text{Fe}_{0.2}\text{O}_{3.5}$ SOFC = Solid Oxide Fuel Cell TXD = Triton X-100 Derived

2. Desiccated LSCF-GDC Cathode Fabrication

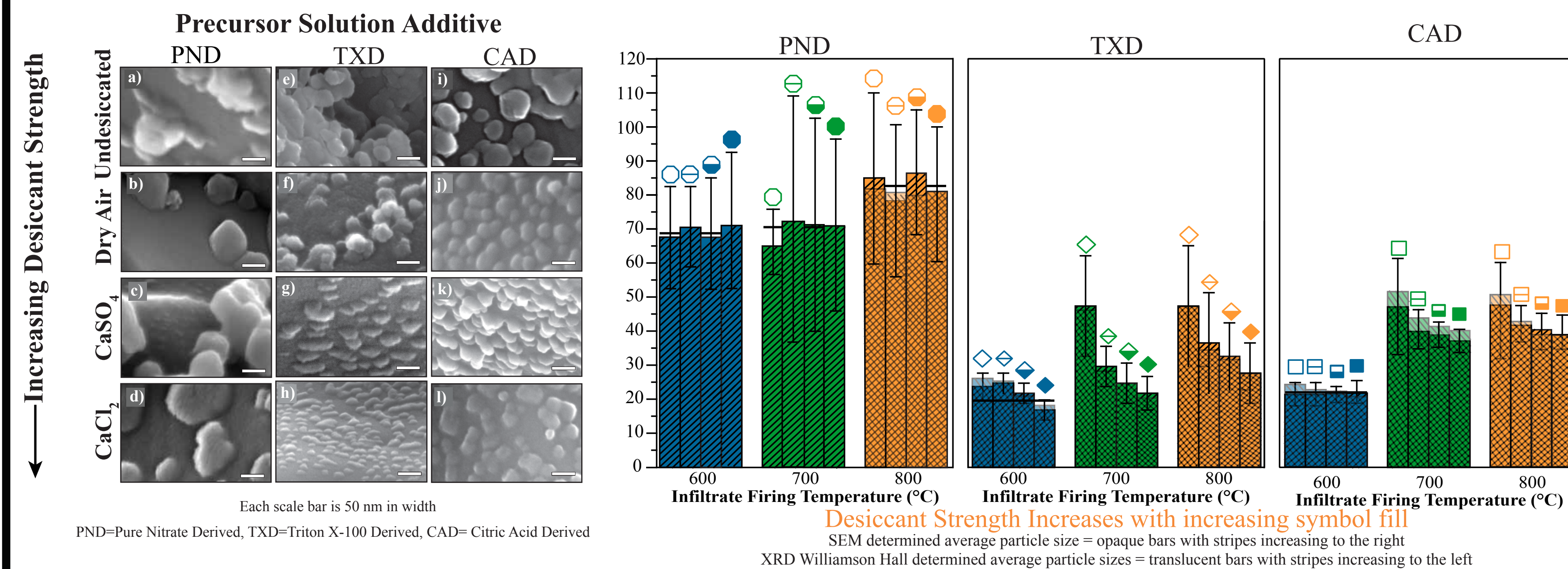


Pure Nitrate Derived (PND), Triton X Derived (TXD), or Citric Acid Derived (CAD)

6. Ceria Pre-Infiltrated LSCF-GDC Cathode Fabrication

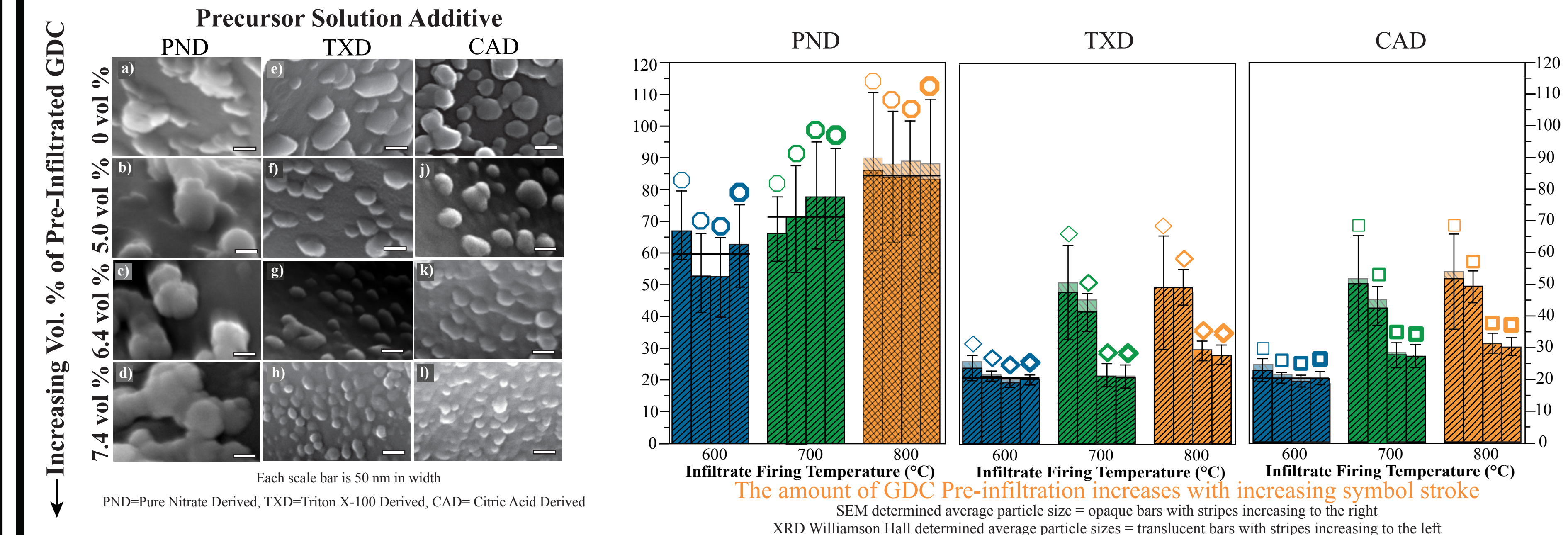


3. Desiccation Reduces LSCF Infiltrate Particle Size



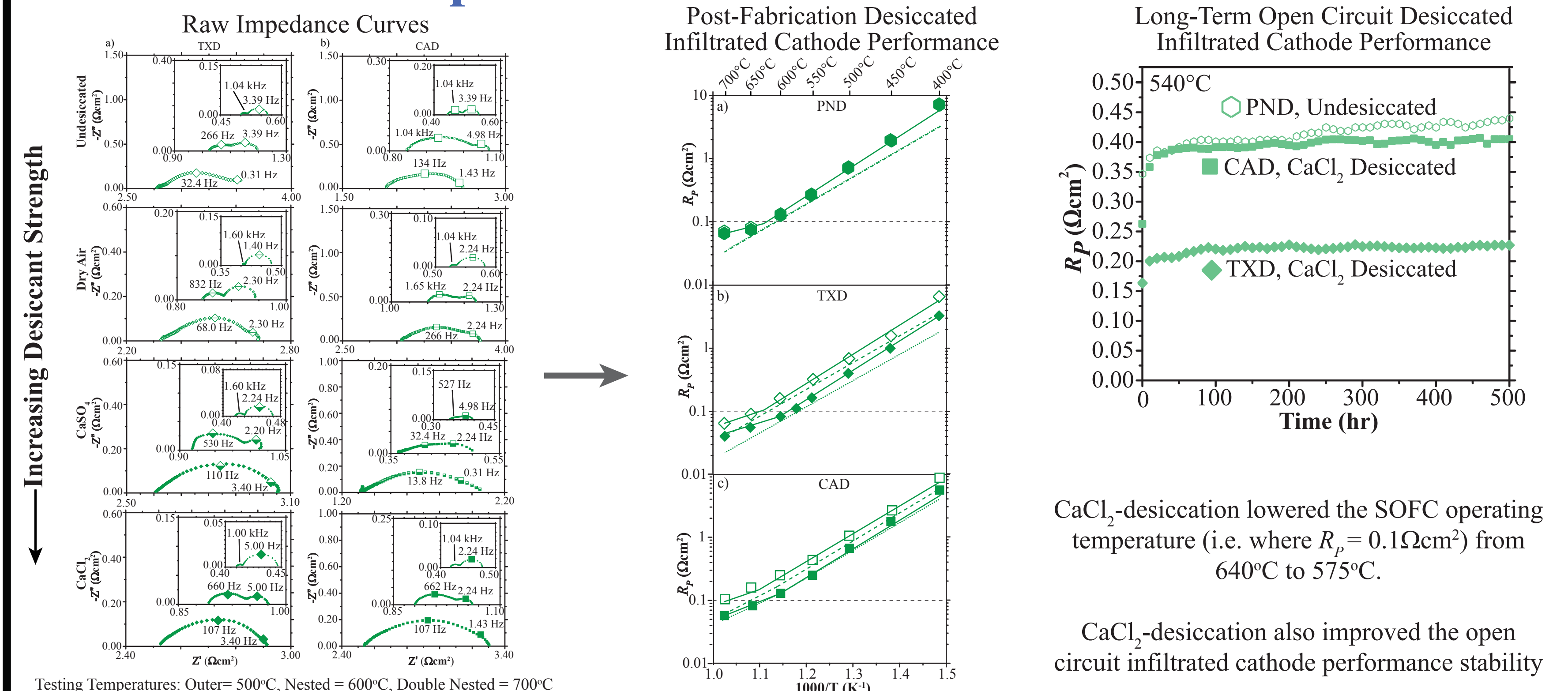
Desiccant Strength Increases with increasing symbol fill
 SEM determined average particle size = opaque bars with stripes increasing to the right
 XRD Williamson Hall determined average particle sizes = translucent bars with stripes increasing to the left

7. Ceria Pre-Infiltration Reduces LSCF Particle Size



The amount of GDC Pre-infiltration increases with increasing symbol stroke
 SEM determined average particle size = opaque bars with stripes increasing to the right
 XRD Williamson Hall determined average particle sizes = translucent bars with stripes increasing to the left

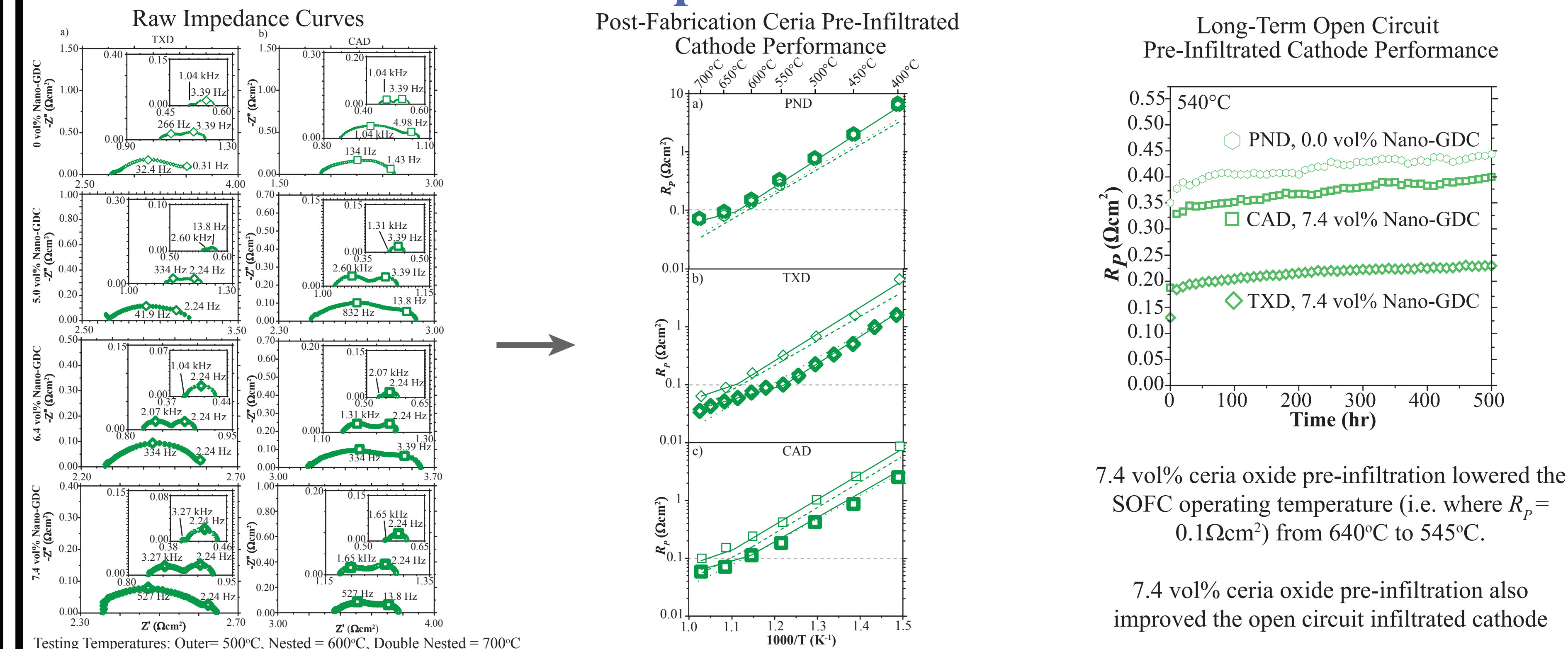
4. Desiccation Improves LSCF-GDC Performance



CaCl₂-desiccation lowered the SOFC operating temperature (i.e. where $R_p = 0.1 \Omega\text{cm}^2$) from 640°C to 575°C.

CaCl₂-desiccation also improved the open circuit infiltrated cathode performance stability

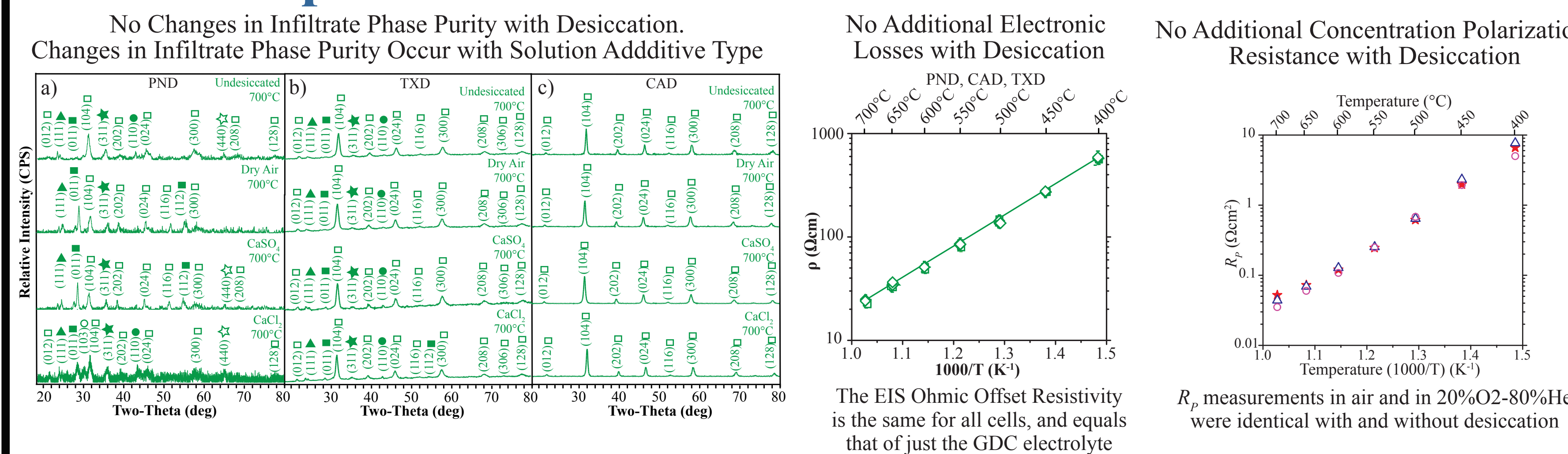
8. Ceria Pre-Infiltration Improves LSCF-GDC Performance



7.4 vol% ceria oxide pre-infiltration lowered the SOFC operating temperature (i.e. where $R_p = 0.1 \Omega\text{cm}^2$) from 640°C to 545°C.

7.4 vol% ceria oxide pre-infiltration also improved the open circuit infiltrated cathode

5. Desiccation Induced LSCF Infiltrate Particle Size Changes Alone Improve LSCF-GDC Performance



The EIS Ohmic Offset Resistivity is the same for all cells, and equals that of just the GDC electrolyte
 R_p measurements in air and in 20%O₂-80%He were identical with and without desiccation

9. Ceria Pre-Infiltration Induced LSCF Infiltrate Particle Size Changes Alone Are Responsible for the Improved LSCF-GDC R_p

- Similar Results to Section 5
- Desiccation reduced LSCF infiltrate particle sizes, improved performance, and improved stability when organic precursor solution additions were present in the infiltrate precursor solutions.
 - Desiccation had no effect on the PND LSCF particle size or the PND LSCF-GDC performance
 - CaCl₂-desiccation reduced the 700°C-fired TXD LSCF average particle size from 48 to 22 nm, and lowered the SOFC operating temperature (i.e. where $R_p = 0.1 \Omega\text{cm}^2$) from 640°C to 575°C.
 - CaCl₂-desiccated TXD LSCF-GDC cells displayed 100-500 hr degradation rates of 1.7% per 1000 hrs, compared to 9.8% per 1000 hr for PND LSCF-GDC cells.
 - Nano-ceria Pre-Infiltration reduced the LSCF infiltrate particle sizes and improved the initial performance of LSCF-GDC cathodes. Unfortunately, the degradation rates of ceria pre-infiltrated cathodes were similar to those observed with conventional (PND) LSCF-GDC cathodes.