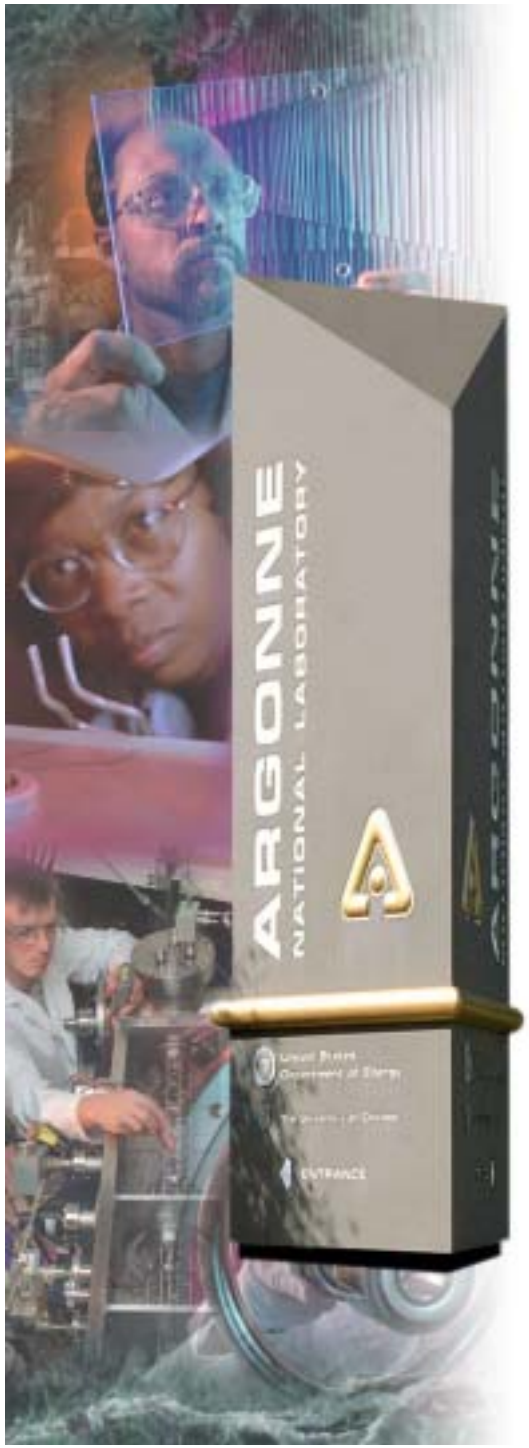

ANL Experience and Suggestions for SOFC Seals

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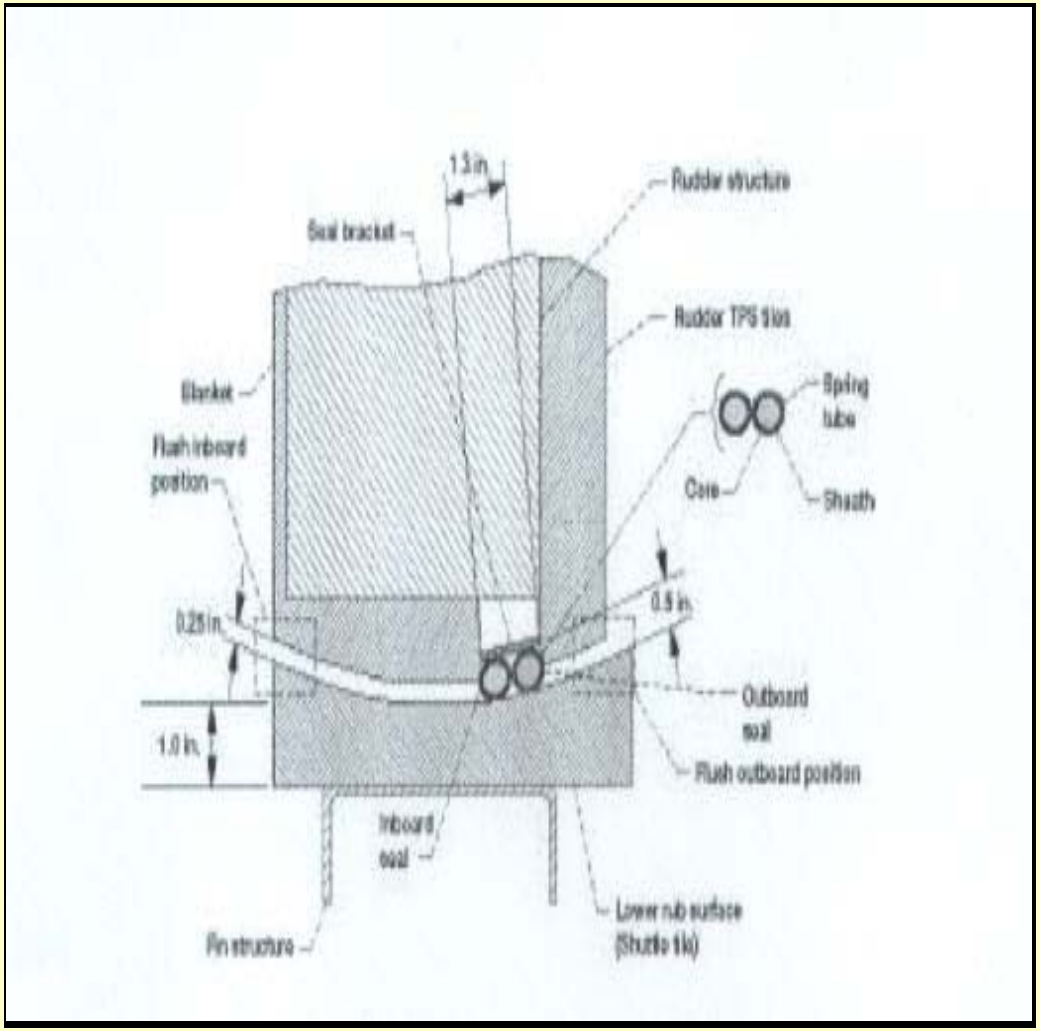
Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

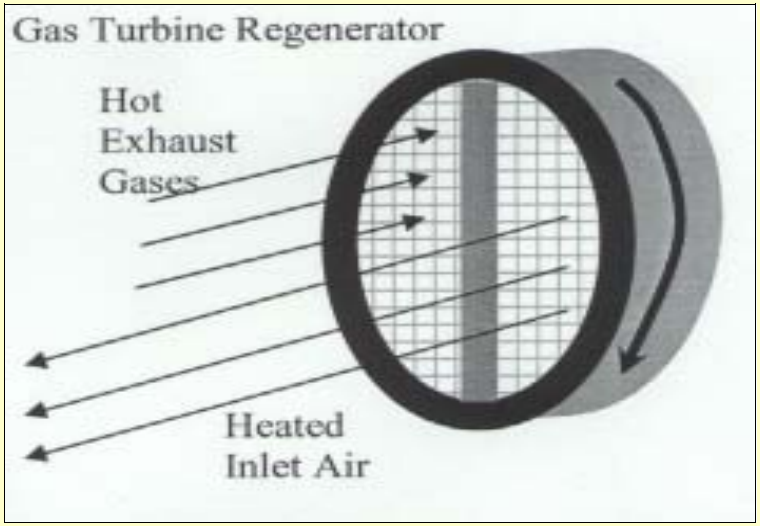
Rudder/Fin Seal in X-38 Re-entry vehicle

A metallic “spring-tube” is used to prevent hot air from contacting the structure

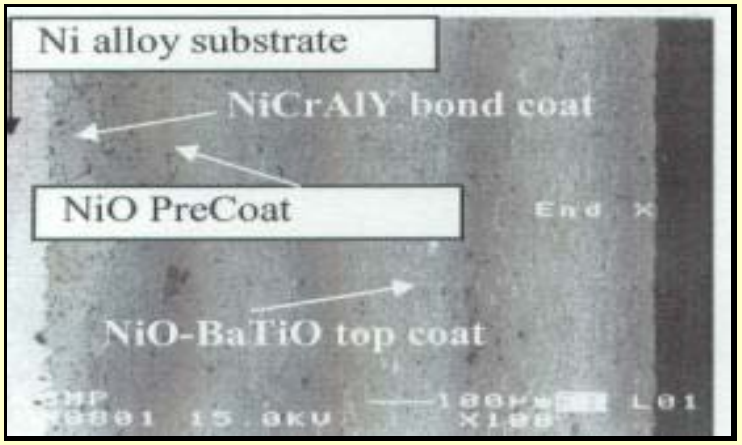


Gas Turbine Regenerator Seal

Turbine exhaust gas at >1000°C was sealed against ambient air by a rotating drum (1’ x 3/16’) seal area



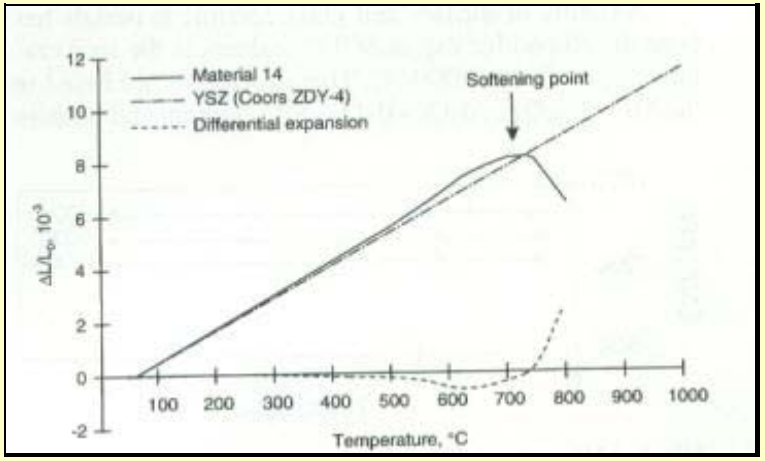
The critical item is the compliance of the bond coating



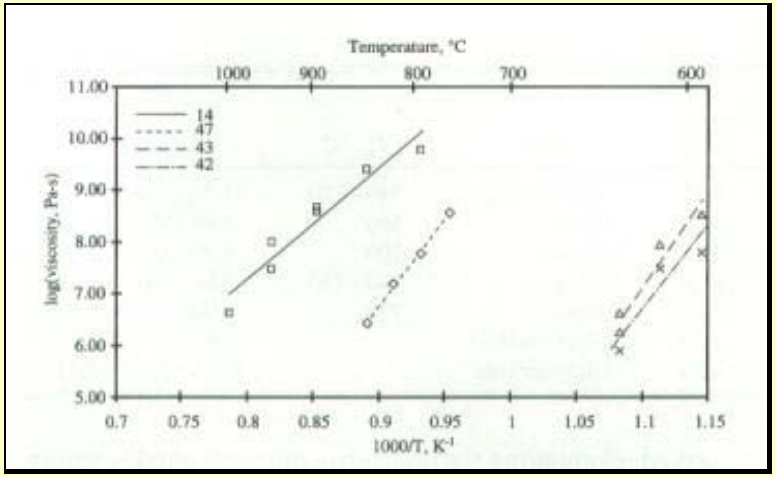
Properties of the ANL Glass/Ceramic

24% SrO, 20% La_2O_3, 7% $A\ell_2O_3$, 40% L_2O_3, 9% SiO_2

The thermal expansion coefficient was closely matched with zirconia

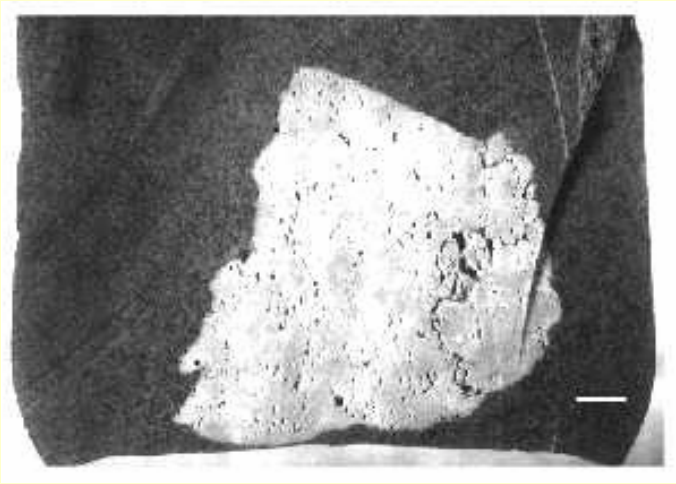


The viscosity was high enough to prevent wicking

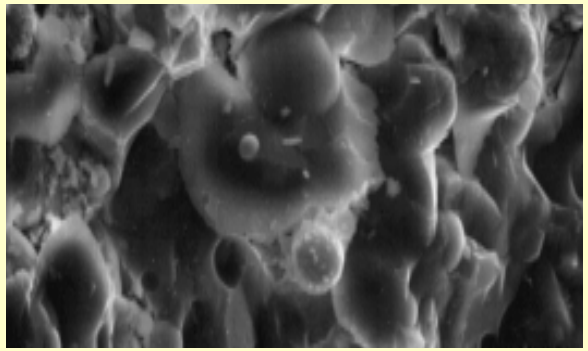


Successful Applications

Road Repair Sealant



Oil-Well Sealant



Impermeable Microstructure

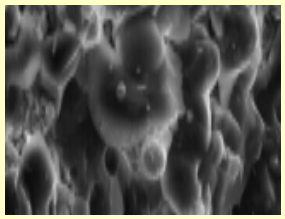
Strong Interfacial Bond

Chemically Bonded Phosphate Ceramic Sealants

Successful Applications

Road Repair Sealant

Oil-Well Sealant



Impermeable Microstructure

Strong Interfacial Bond

Critical Issues Addressed

- **Interfacial delamination**
- **Thermal mismatch stress**
- **Thermal fatigue cracking**
- **Gas permeability/leak**

Applications to Fuel Cells

- Issues**: Interface delamination/cracking, materials instability, gas-leak**
- Sealant Composition and Performance: **Phosphate and phospho-silicate based ceramics with chemical and thermal stability in SOFC.**
- Approach: **Tailored expansion coefficient (~10x10^{-6}/°C) and graded microstructure to reduce residual stresses, Improved toughness to reduce thermal fatigue, Superior interfacial strength by chemical bonding.**