Microturbine Materials Technology Activities

- Si_3N_4 Ceramics
  - Environmental Stability (Honeywell, Kyocera, ORNL)
  - Mechanical Properties (UDRI, ORNL)
  - Protective Coatings (ORNL)
  - Reliability and Life Prediction (NASA, ORNL)
  - NDE (ANL)
- Recuperator Materials
  - SOA Materials Assessment (ORNL)
  - Advanced and Improved Materials (ORNL)
  - Microturbine Materials Test Facility (ORNL)
- Heat Sinks
  - High Conductivity Carbon Foam (ORNL)

Advanced Microturbine Hot Section Materials Program Objectives

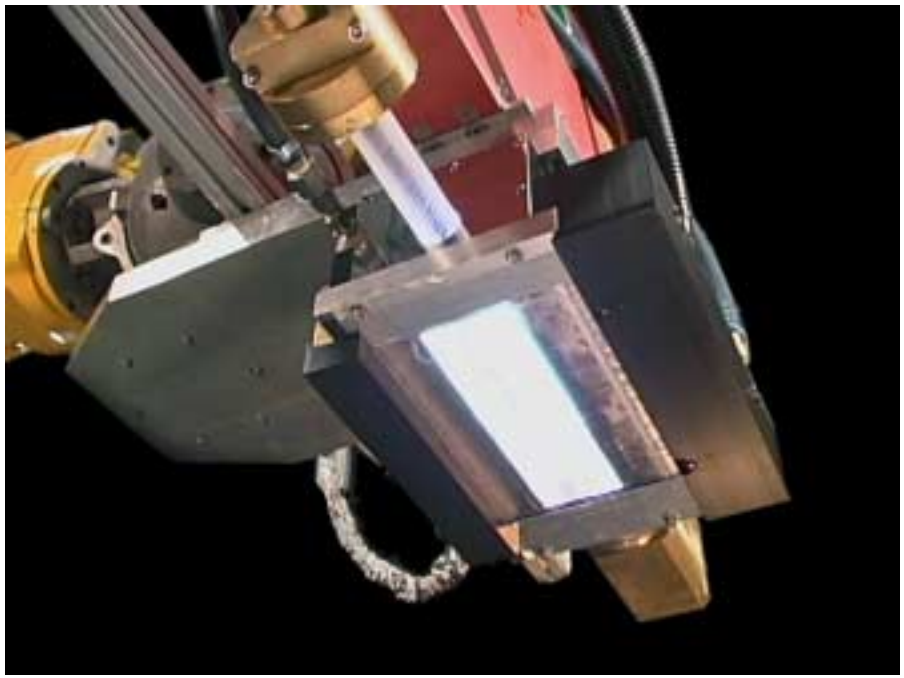
- Develop a design envelope of anticipated operating conditions for a Si_3N_4 rotor for an advanced microturbine
- Evaluate the effects of temperature, pressure, water vapor, and other gas species typical of advanced microturbines on the environmental resistance and mechanical stability of candidate Si_3N_4 ceramics
- Complete an assessment and initial evaluation of methods to improve or enhance the environmental stability of candidate Si_3N_4's (coatings)
- Enhance current structural ceramic reliability and life prediction capabilities to incorporate environmental and coating issues
- Develop advanced ceramic manufacturing approaches capable of reducing the development cost and time for the prototype-to-production transition (optional)

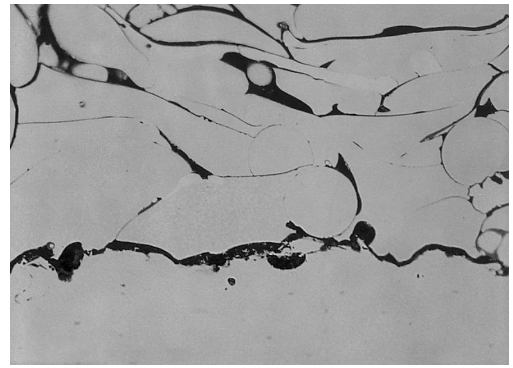
Program Participants

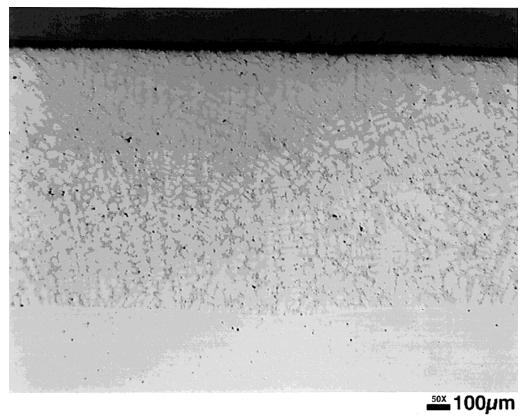
- **Honeywell Ceramic Components**
  - Phase I
    - Task 1: Advanced Microturbine Scoping Studies and Research Plan
  - Phase II
    - Task 1: Environmental Effects Evaluation (Uncoated)
    - Task 2: Technology Assessment for Environmental Protection
    - Task 3: Rapid Prototyping
- **Kyocera Industrial Ceramics Corporation**
  - Phase I: Develop Database of Application Requirements
  - Phase II: Provide Data on Performance of Materials in Microturbines
    - Evaluate Baseline (Uncoated), Coated, and Alternate Materials

Both teams include microturbine manufacturers

Novel Infrared Processing May Produce Cost Effective Coatings



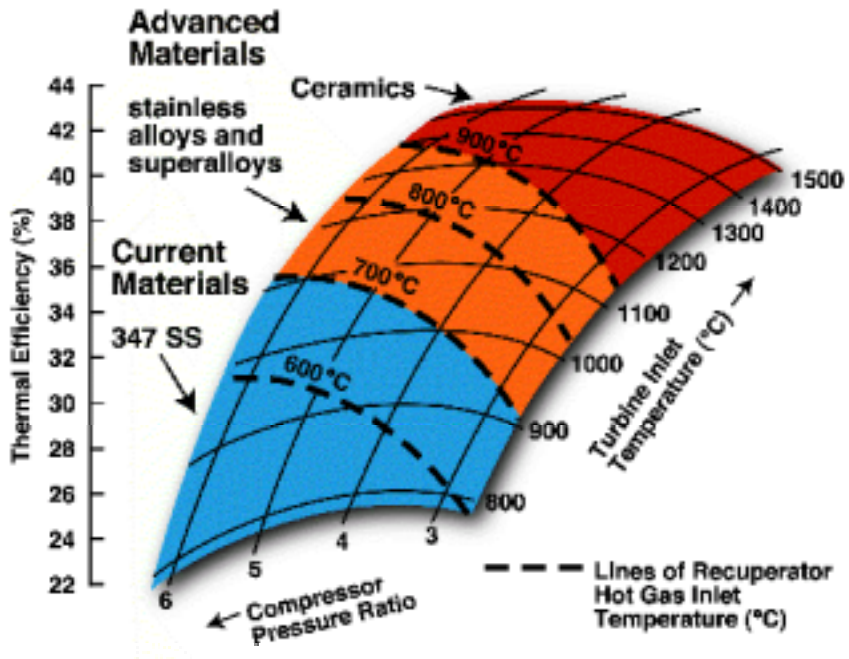




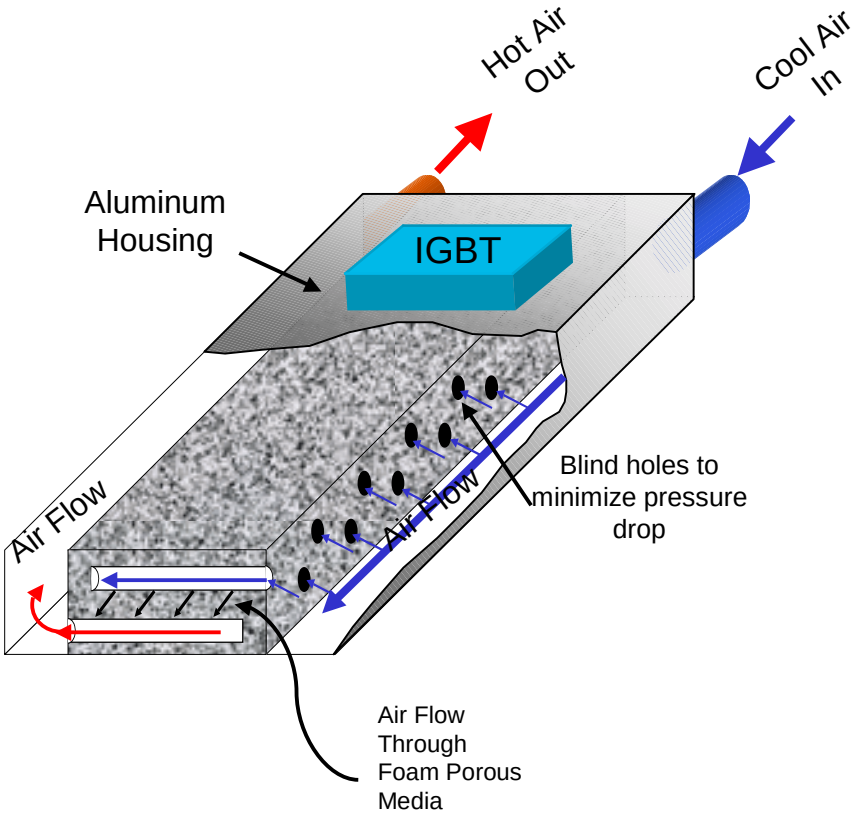
Slurry-based and plasma sprayed coatings are being densified or fused using the infrared lamp to improved their corrosion resistance

Advanced Recuperator Materials

- Advanced Microturbines Will Operate at Higher Temperatures and Demand Improved Recuperator Materials
- Current Activities Focused on:
  - Creep-resistant Materials (600-750°C) (ORNL)
  - Oxidation-resistant Materials (750-900°C) (ORNL)
  - Microturbine Materials Test Facility (ORNL)



Carbon Foam Heat Exchangers are being Optimized for Heat Transfer and Pressure Drop



Second Generation Carbon Foam Heat Sink for Power Electronics

	Heat Transfer Coefficient h, ($W/m^2 \cdot K$)	$\Delta P/L$ (psi/in)
Air Flow →		
Solid Foam Air Flow →	2600	2
Finned Air Flow →	1000	<0.05
Pin-Fin Air Flow →	1500	0.05
Blind-holes (pin fin negative) Air Flow →	3500	1
Blind-holes (parallel to air flow)	3100	1
Current Radiators	20-40	<0.05