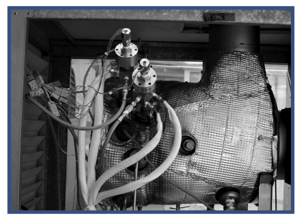
Materials for Advanced Microturbine Recuperators

Microturbines and turbines are being developed that operate at higher temperatures to achieve efficiencies approaching the DOE goal of 40%. Achieving this goal requires the availability of advanced yet cost-effective recuperator materials to replace currently used 347 stainless steel. The two primary requirements for recuperator materials are creep and corrosion resistance for extended periods at temperatures of 650°C. ORNL is collaborating with industry to develop improved recuperator alloys, screen candidate materials, characterize the performance of the selected alloys, and formulate life prediction models.

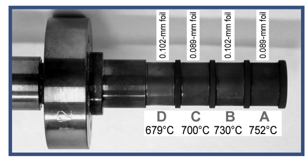
Processing

Screening

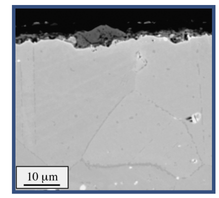
ORNL is screening and evaluating metallic foils of candidate materials inside a Capstone microturbine that was modified to operate at higher turbine outlet temperatures.



ORNL's microturbine recuperator test facility



Sample holder with 120® foils

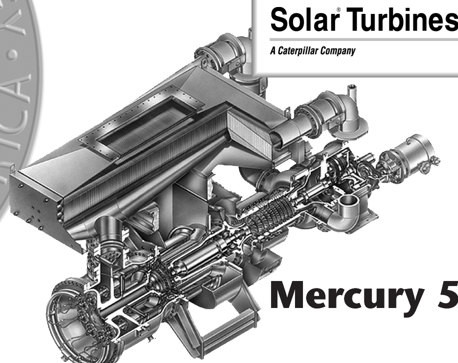


Oxide scale formed on 120® after 500-h exposure at 750°C

IR250

C200

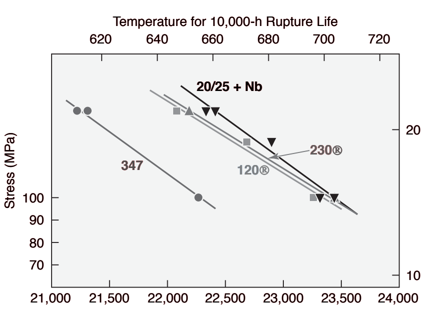
DOE's Distributed Energy Microturbine Materials Program



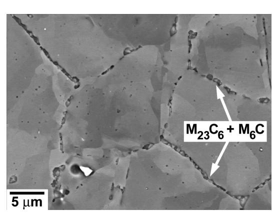
Mercury 50

Evaluation

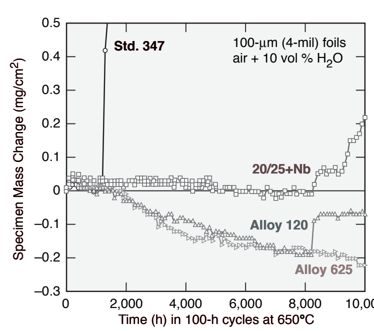
The most promising alloys identified to date are 120®, 625, and 20Cr/25Ni+Nb with the most cost-effective option being the austenitic alloy 20/25+Nb.



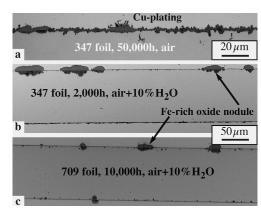
Stress-rupture of metallic alloys



Carbide precipitates improve creep resistance of alloy 20/25+Nb.



Comparison of the long-term exposure of alloy foils in humid air at 650 °C



Oxide scales formed on alloys oxidized at 650°C for (a) 347SS: 50,000 h; (b) 347SS: 2,000 h in humid air; (c) 20/25+Nb; 10,000 h in humid air

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