High Performance Materials (HPM) focuses on materials that will lower the cost and improve the performance of existing and advanced fossil-based power-generation systems. There are four (4) research areas within HPM.

Advanced Manufacturing for High Performance Structural and Functional Materials: Advanced manufacturing provides technologies to fabricate, assemble and join components from high performance materials for advanced FE power generation technologies.

Computational Based Materials Design & Performance Prediction

Computational Based Materials Design and Performance Prediction will enable rapid design of new high performance materials, and provide validated models capable of simulating and predicting long-term performance of high performance materials.

Multi-scale simulation capability to solve the complex physics of the oxidation of metals, transport of charged ions subject to interfacial reactions and long-range electrostatic interactions.

Functional Materials for Process Performance Improvements: Develop functional materials such as sorbents, coatings, catalysts, Chemical-Looping oxygen carriers, and high temperature thermoelectrics needed for advanced FE power generation technologies.

Computational Simulation of Oxidation Rate of High Temperature Alloys

Oxidation and Reduction cycles: Ionic Diffusion

Core-Shell Structured Oxygen Carrier for Chemical Looping Combustion

Advanced Structural Materials for Harsh Environments: Develop advanced structural materials that are needed for the harsh operating environments (e.g., high temperature and pressure) of advanced FE power generation technologies.

Fabrication in Alstom Chattanooga, TN shop

World’s first steam oxidation/fireside corrosion test loop operating at 760°C (1400°F)

Installed Test Loop

Prior to Welding

Being Welded

After Assembly

Materials included:

- 740H, CC91, H98W, Super 304H, Coating Overlays and Others

- Operated for over 5,000 hours above 760-deg C

- Initial evaluations of test samples show little to no metal oxidation or corrosion loss.
The High-Performance Materials research area focuses on materials R&D that will lower the cost and improve the performance of advanced fossil-based power-generation systems. Advanced-Ultra-Supercritical (AUSC) technology will use advanced structural materials to achieve a step increase in the operating efficiency of coal fired power plants.

Laboratory scale tests were performed on the most promising alloys to determine relevant mechanical properties, resistance to steam-side oxidation and fire-side corrosion in boilers. The alloys were also tested for their fabricability, weldability, and castability.

Research was also conducted on nickel superalloy materials for an AUSC steam turbine. Work focused on developing the specific methods for casting and forging these materials and determining the weldability, mechanical properties and repairability of the candidate alloys for turbine rotors, casings and valves.

The AUSC Consortium project focused on existing nickel super-alleys that are capable of operating at AUSC temperatures and pressure. Most of these nickel super-alleys were developed for use in gas turbines or jet engines.