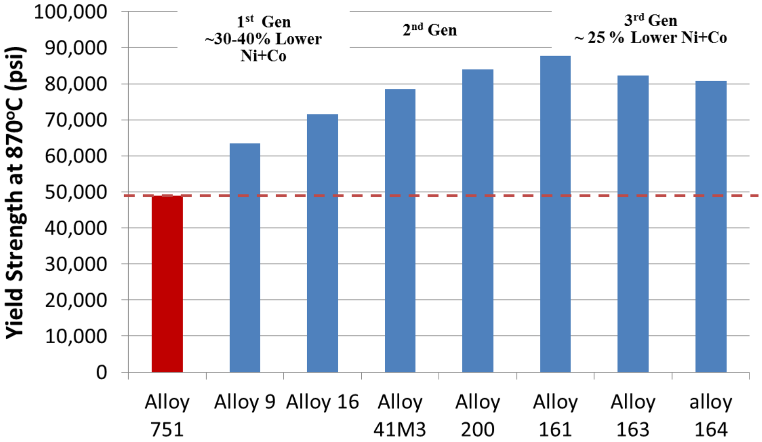
Low-Cost, High-Strength Ni-Fe-Cr Alloys for High-Temperature Applications

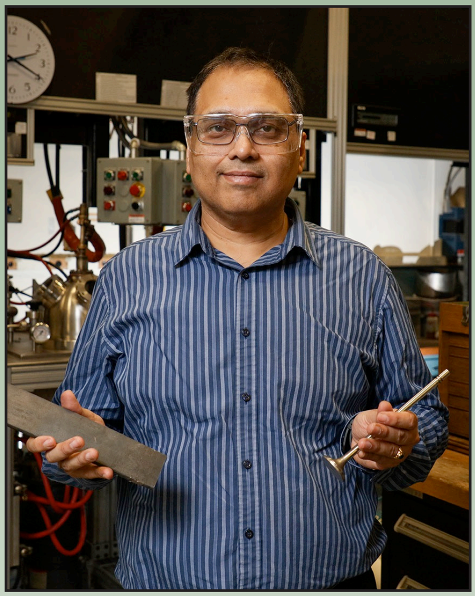
Problem: Exhaust gas temperatures in high-efficiency light-duty and heavy-duty engines are expected to increase steadily through 2025 and beyond. This has created a demand for new materials that can meet the performance and cost targets for components, such as exhaust valves, which are exposed to these higher exhaust gas temperatures. Currently Ni-based alloy 751, which contains about 71% nickel, is used in high-performance exhaust valve applications. Alloy 751 has strength and oxidation resistance up to about 800–850°C. However, above 850°C, this alloy rapidly loses its strength.

Solution: Using computation modeling techniques, ORNL researchers have developed several new low-cost, high-strength Ni-Fe-Cr alloys with yield strengths up to ~80% better than that of alloy 751. In addition, these alloys have been designed to contain 50% or less by weight of Ni+Co, which is about 25–40% lower than that of alloy 75, translating to material cost savings.



Yield strengths of new alloys are up to 80% greater than that of alloy 751, which is currently used as a valve material.

Impact: The low-cost, high-strength Ni-Fe-Cr alloys have the potential to be used for exhaust valves in the next generation high-efficiency engines. Additionally, high-temperature applications exist in the industrial manufacturing, chemical, gas turbine, power, and aerospace markets. For example, low-cost, high-strength Ni-Fe-Cr alloys could enable manufacturing of lighter heat-treating baskets and fixtures, radiant tubes, wire mesh furnace belts and basket liners, fluidized-bed components, muffles and retorts, and recuperators.



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Intellectual Property

Low-cost Fe-Ni-Cr alloys for High Temperature Valve Applications; US9605565 B2

Low-Cost, High-Strength Fe-Ni-Cr Alloys for High Temperature Exhaust Valve Applications; US9752468 B2

Publications

- R. N. Andrews, J. Serio, G. Muralidharan, and J. Ilavsky, "An in-situ USAXS-SAXS-WAXS study of precipitate size distribution evolution in a model Ni-based alloy," *J. Appl. Crystallogr.*, 2017 June 1; 50 (Pt. 3): 734–740.

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