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Resolving the structure and properties of τ_1-Cr-Ni-Al for high temperature protective applications[1] J. W. SIMONSON, J. E. NICASIO, H. ILYAS, J. PABLA, Department of Physics, Farmingdale State College, K. HORVAT, Department of Mechanical Engineering Technology, Farmingdale State College, J. C. MISURACA, JEOL USA, Inc. — Increasing the temperature of the steam in turbine power plants enhances thermal efficiency while reducing CO_2 emissions. Exposed steel components, however, must be coated to withstand the harsh environments present in next-generation advanced ultra-supercritical plants. Proposed coating materials must exhibit low density, high hardness, high toughness, excellent oxidation resistance, and low thermal conductivity. With an eye towards satisfying this diverse array of requirements, we report the properties of the so-called τ_1 phase of Cr-Ni-Al. We resolve the previously controversial composition and crystal structure of this material. The complex structure is composed of distorted icosahedra and octahedra of Al, with nearest-neighbor transition metal-Al bond lengths as short as 2.4 $\mathring{A}$, far shorter than typical distances in Ni-Al and Cr-Al binaries. Accordingly, Vickers hardness is 6.88 ± 0.13 GPa, as hard as extra-high-hardness armor plating at only 45% the density. We discuss these properties in light of the result of transport and oxidation resistance measurements. The apparent dependencies of these properties on crystal structure suggests new criteria for materials research.

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