

Strong Magnetic-Field Treatment Strengthens NiAl-Cr(Mo)-Hf Alloy

NiAl-Cr(Mo)-Hf alloys offer significant potential for use as high-temperature, lightweight structural materials. They show good strength at high temperatures, good oxidation resistance, and high wear resistance. These alloys, however, are very brittle and have low tensile strengths, particularly at room temperature. Various efforts to improve the ductility of these alloys have been marginally successful. A method has now been reported to significantly improve the ductility and bending strength of the alloy. By subjecting a NiAl-Cr(Mo)-Hf alloy to a high magnetic field, G.J. Ma and W.L. Zhou of the Dalian University of Technology, J.T. Guo of the Shengyang Institute of Materials Research, and their co-workers have increased the bending strength of the alloy by 75%.

As reported in the February 2005 issue of the *Journal of Materials Research* (p. 295; DOI: 10.1557/JMR.2005.0047), rectangular

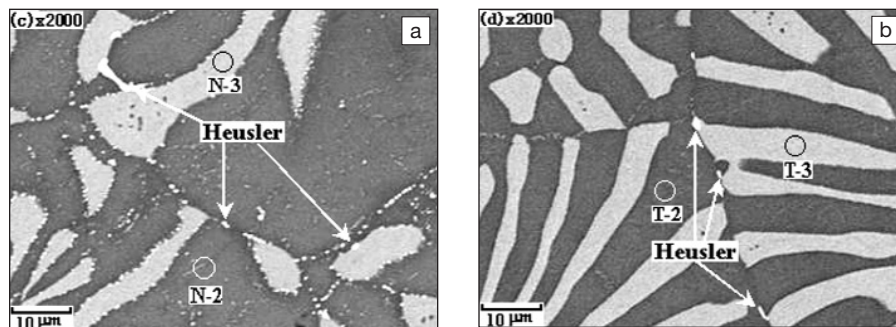


Figure 1. Electron probe microanalysis of the microstructures (a) without magnetic-field treatment, in which N-2 represents the NiAl phase and N-3 represents the Cr(Mo) phase; and (b) after magnetic-field treatment, in which T-2 represents the NiAl phase and T-3 represents the Cr(Mo) phase. Reproduced with permission from the *Journal of Materials Research* **20** (2) (February 2005), p. 295; DOI: 10.1557/JMR.2005.0047. © 2005 Materials Research Society.

cross-sectional NiAl-Cr(Mo)-Hf alloy specimens, formed from a nominal composition of Ni-33Al-28Cr-5.5Mo-0.5Hf, were heated to 900°C under a 10 T homo-

geneous high magnetic field. Upon cooling to room temperature, the bending strength of the specimens was characterized using the three-point bending

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method. While the average bending strength of the untreated alloy was 245 MPa, the average bending strength of the alloy treated with the magnetic field was 430 MPa, roughly a 75% increase. The elastic modulus remained unchanged. Scanning electron microscopy observations of the fracture surfaces of the treated specimens showed typical ductile fracture characteristics. The fracture surfaces of the untreated specimens clearly showed brittle characteristics with microcracks, the researchers reported.

In order to understand the underlying mechanism, C.W. Wu in the Department of Mechanical Engineering at Dalian said that the research group performed electron probe microanalysis on the untreated and treated samples. The untreated alloy consists of NiAl, Cr(Mo), and Heusler phases. These do not change when the alloy is heated to 900°C. In the magnetic-field-treated samples, the Heusler phases at the NiAl/Cr(Mo) grain boundaries were partly dissolved into the NiAl and Cr(Mo) phases. In addition, small Heusler phase particles at the Cr(Mo) and matrix phase interfaces partially dissolved into the NiAl matrix (see Figure 1). The researchers speculated that the dissolution of the Heusler phase due to the high-magnetic-field treatment contributed to the improvement in bending strength and ductility of the alloy. The exact mechanism, however, remains unclear.

GOPAL RAO

Metalorganic Building Block Enables Synthesis of Four Supramolecular Isomers

While supramolecular isomerism is widely encountered in the field of crystal engineering, the majority of these that have been reported require a co-existence of different guest components for production. An elementary system of supramolecular isomers that has been encountered is the zero-dimensional ring-like, one-dimensional zigzag, and helical chains that can be derived from a stoichiometry of 1:1 metal/ligand molar ratio. Now, X.-M. Chen and colleagues from Sun Yat-Sen University in China have fabricated low-dimensional supramolecular isomerism (chairs, zippers, and chains) of 0D/1D coordination polymers without the use of guest components.

By using a binary Cu^{I} triazololate $[\text{Cu}^{\text{I}}(2\text{-Hpytz})_x]$ (2-Hpytz = 3,5-di-(2-pyridyl)-1,2,4-triazololate) pre-designed, metalorganic building block, the researchers isolated four types of air-stable crystals of different colors and/or shapes. Crystallographic studies revealed the stoichiometry of 1:1 (metal/ligand) for all

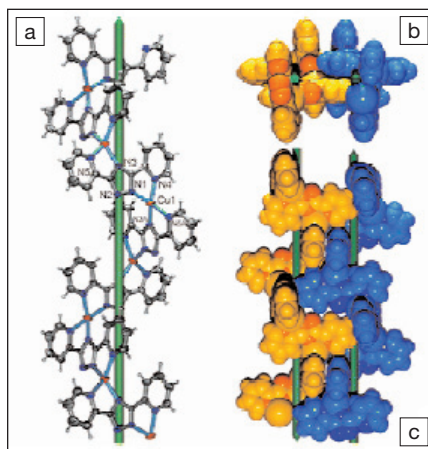


Figure 1. ORTEP drawing (50% A: 0.5 - y, x - 0.5, z - 0.25) of a single 41 helix in Complex IV (a). Top (b) and side (c) views of two adjacent helical chains in space-filling modes. ORTEP stands for Oak Ridge thermal-ellipsoid plot program. Reproduced with permission from *Chemical Communications* (2005), p. 1258; DOI: 10.1039/b416095a. © 2005 Royal Society of Chemistry.

complexes isolated. The researchers' findings were reported in the March 1 issue of *Chemical Communications* (p. 1258; DOI: 10.1039/b416095a).

The different complexes were synthesized based on the different conformations of the coordinating ligands. Complex I was a red polyhedral crystal that possessed a centrosymmetrical, chair-like tetrameric superstructure. The researchers attributed this superstructure to the *cis-cis* and *cis-trans* 2-Hpytz ligand conformations. Complex II (with the conformation of Hpytz ligand, *cis-trans*, and half a *cis-cis*) was a red column crystal that has a highly distorted tetrahedral environment that produced a zipper-like double-chain superstructure. Complex III (with the conformation of pytz ligand, one *cis-trans*, and a distorted tetrahedral Cu^{I} metal center) was an orange column crystal that is centrosymmetric, which gave rise to anti-parallel, aligned, polar zigzag chains, the researchers said.

Complex IV (see Figure 1) was an orange needle-like crystal that gave rise to a homochiral structure with an anti-parallel, aligned, single-stranded 4_1 helix, which is rare, the researchers said. This complex was synthesized by varying the reaction times and conditions. The researchers said that this system represents the first example of low-dimensional, supramolecular isomerism in coordination polymers and gives rise to controlled crystallization of individual isomers.

LARKEN E. EULISS

Wavelength Multiplexing of Microsphere Resonators Used to Characterize Nanolayers

Biosensors are widely used in clinical and military applications as well as for the characterization of biomolecular interactions important in drug discovery. While traditional optics employ nanolayers made from inorganic insulators, semiconductors, and metals, the emerging field of biophotonics employs DNA, proteins, lipids, and hydrogels in soft condensed biofunctional layers formed at aqueous-solid interfaces. Recently, S. Arnold and co-researchers from Polytechnic University in New York have developed a non-invasive method to optically characterize bioactive nanolayers formed *in situ* on a silica microsphere.

As reported in the March 1 issue of *Optics Letters* (p. 510), the research team developed an appropriate theory, validated it experimentally, and then demonstrated their method's utility by optically characterizing a biophysically relevant hydrogel. Focusing on the theoretical effect that a nanolayer has on a microsphere's whispering-gallery modes (WGMs), the researchers applied perturbation theory to transform the electric-field equations for the transverse electric WGMs to make the problem analogous to the solution of the Schrödinger equation with an appropriate effective potential. The optical transmission spectra of the WGMs have resonances that are perturbed by the addition of nanolayers of material. By judiciously choosing two wavelengths, λ_1 and λ_2 (760 nm and 1310 nm, respectively), the researchers found that the ratio S of the fractional shifts in the resonances of the WGM wavelengths has the limit of λ_1/λ_2 (0.58, in this case) for a thick layer and a limit approaching unity for an ultrathin layer. In addition, using two equations derived by the researchers, both the layer thickness and the optical dielectric constant can be independently determined from the measurements of the wavelength shifts of the WGMs.

The researchers conducted two experiments to test these limits. In the first, as a monolayer of bovine serum albumin (~3 nm thick) was formed on a silica microsphere, monitoring of the resonances associated with the two wavelengths showed that each shifted about the same amount, $S = 1$, consistent with the theory for a thin layer on the microsphere. In the second test case, the researchers injected NaCl into the water surrounding a microsphere and incrementally increased the salt concentration by 0.1 M. A plot of the resonance shift at λ_1 versus the resonance shift of λ_2 displayed a slope of 0.54, consistent with that predicted for the for-