

# Processing of $\text{Ni}_{30}\text{Pt}_{20}\text{Ti}_{50}$ High-Temperature Shape-Memory Alloy Into Thin Rod Demonstrated

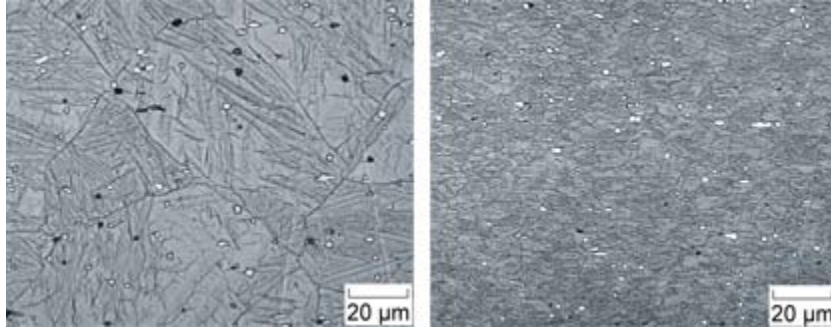
High-temperature shape-memory alloys (HTSMAs) based on nickel-titanium (NiTi) with significant ternary additions of palladium (Pd), platinum (Pt), gold (Au), or hafnium (Hf) have been identified as potential high-temperature actuator materials for use up to 500 °C. These materials provide an enabling technology for the development of “smart structures” used to control the noise, emissions, or efficiency of gas turbine engines. The demand for these high-temperature versions of conventional shape-memory alloys also has been growing in the automotive, process control, and energy industries. However these materials, including the NiPtTi alloys being developed at the NASA Glenn Research Center, will never find widespread acceptance unless they can be readily processed into useable forms.



*Piece of  $\text{Ni}_{30}\text{Pt}_{20}\text{Ti}_{50}$  0.056-in.-diameter wire processed by high-temperature swaging.*

Consequently, Glenn researchers have been working with various metal fabricators in the processing of HTSMA, mapping successful processing conditions for the extrusion and forging of wrought material. In addition, one of the necessary steps in the eventual maturation of these alloys is the ability to produce the material into thin rod or wire form. Therefore, we recently demonstrated successful processing conditions for the fabrication of HTSMA thin rod by high-temperature swaging in conjunction with Rhenium Alloys, Inc. (see the preceding photograph).

Thermomechanical processing of a  $\text{Ni}_{30}\text{Pt}_{20}\text{Ti}_{50}$  alloy into fine-diameter rod form results in at least an order-of-magnitude reduction in grain size in comparison to the starting grain size of the as-extruded material (as seen in the following photomicrographs). We anticipate that this modification to the microstructure of the NiPtTi will significantly improve the mechanical properties of the alloy. Therefore, plans call for future efforts to characterize the mechanical properties of the HTSMA rod and to further develop processing conditions for the eventual fabrication of fine-diameter wire.



*Left: Microstructure of as-extruded alloy before swaging. Right: Microstructure of the final 0.056-in.-diameter Ni<sub>30</sub>Pt<sub>20</sub>Ti<sub>50</sub> rod, resulting in at least an order-of-magnitude reduction in grain size.*

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