## Deformation Assisted Homogenization of IN-706 Ingot and Effect on Microstructure and Mechanical Properties

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## Abstract

Triple-melted VIM-ESR-VAR large IN-706 ingots (32–36 in. dia x 66–100 in. height) are cast to fabricate very large forgings utilized for several end applications. Although macrosegregations, greater than  $^{1}/_{16}$  in. dia, are not detected in most of these ingots, some microsegregations rich in hardening elements (Nb, Ti) are observed in ingot sections. A thermal treatment of  $1600^{\circ}\text{F}/1-2$  hr followed by air cooling reveals these segregated areas which exhibit a high density of needle-type precipitates [possibly delta ( $\delta$ ) or eta ( $\eta$ ) phase]. Conventional homogenization of these ingots in the range of 2000° to 2200°F for 18 to 72 hr did not eliminate this type of microsegregation. Attempts were made to study the effect of mechanical deformation (hot working) and homogenization on microsegregation.

Optical micrographs indicate that a 2:1 upset with a redraw followed by a 2000° to 2200°F ±25°F homogenization for 24 to 48 hr reduces the extent of microsegregation. However, electron microprobe line scan and spot scan analysis did not reveal a significant difference for Nb, Ti distribution between the conventionally homogenized and deformation assisted homogenized billet stock. Small scale pancake forgings (6 in. dia x 1 in. thick) fabricated from these billet stocks, however, indicate that the deformation assisted homogenized ingot sections develop a more uniform grain size and microstructure compared to those from a conventionally homogenized ingot section.