THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
FALL COLLOQUIUM SERIES PRESENTS:

# Michael Mills

Chair and Professor, Materials Science & Engineering

Ohio State University

## *Local Phase Transformations: A New Creep Strengthening Mechanism in Ni-Base Superalloys*

Polycrystalline Ni-based superalloys are vital materials for disks in the hot section of aerospace and land-based turbine engines due to their exceptional microstructural stability and strength at high temperatures. In the drive to increase operating temperatures and hold times in these engines, hence increasing engine efficiency and reduction of carbon emissions, creep properties of these alloys becomes increasingly important. At these higher temperatures, new deformation modes become active. Several alloy compositions and microstructure variants of commercial disk alloys are being explored, including $\gamma'$ strengthened alloys as well as compositions promoting $\gamma'$ and $\gamma''$ co-precipitation. Microtwinning and stacking fault shearing are important operative mechanisms in the critical 600-800°C temperature range. Advanced electron-microscopy-based techniques have been used to gain new insights into these mechanisms and the rate-limiting processes during high temperature deformation. Atomic-scale chemical and structural changes associated with stacking fault and microtwin interfaces within $\gamma'$ precipitates have been identified and indicate that local phase transformations (LPT) occur commonly during creep of superalloys. Furthermore, the important deformation modes can be modulated by LPT formation, enabling a new path for improving high temperature properties. This work is part of a GOALI-DMREF program funded by the National Science Foundation in which collaborators are exploring the thermodynamic driving force for LPT formation using DFT modeling, and phase field dislocation dynamics modeling is being used to explore the interaction of dislocations with $\gamma'$ microstructures under the cooperative shearing and local compositional changes associated with the LPT mechanism.

**Professor Mills** earned his PhD degree in Materials Science and Engineering at Stanford University in 1985. He joined the Department of Materials Science and Engineering at the Ohio State University in 1994 after a two-year research associate appointment at the Ecole Polytechnique Federale-Lausanne, Switzerland, and a six-year appointment as Senior Member of Technical Staff at Sandia National Laboratories, Livermore, CA. He is presently Chair of the Department of Materials Science and Engineering at OSU (he was Interim Chair in 2014-2015). He is a Fellow of the American Society for Metals, was inducted as Fellow of TMS in 2015, and has received the Oleg D. Sherby Award from TMS for research in high temperature materials. Mills received the Alexander Von Humboldt Research Fellowship in 1996 and in 2019 he received the Alexander von Humboldt Research Award. He was awarded the Heyn Medal from the DGM (Deutsche Gesellschaft für Materialkunde).

**Tuesday, November 2 • 4 pm CT • Tech L211**

Registration is required. RSVP here.

*Questions? Contact elena.lindstrom@northwestern.edu.*

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