UNIVERSITY OF CALIFORNIA, IRVINE

THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Is Proud to Host a Seminar by:

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Dept. of Materials Science and Engineering
Technion
Israel Institute of Technology

Thursday, March 16, 2023
2:00-3:20 PM
Location:
McDonnell Douglas Engineering Auditorium

BREAKING THE LIMITS OF METALS STRENGTH

Abstract: We studied the uniaxial compression behavior of micro- and nanoparticles of several elemental metals (Au [1], Ni [2], Ag [3], Mo [4], Pt [5]) and alloys (Ni-Co [6], Ni-Fe [7]). The particles were obtained by solid state dewetting of thin metal films and bi-layers deposited on sapphire substrates. The high homological temperatures employed in dewetting process ensure the low concentration of dislocations and their sources in the particles. The particles compressed with a flat diamond punch exhibit purely elastic behavior up to very high values of strain approaching 10%, followed by a catastrophic plastic collapse. The uniaxial yield strength of the particles defined as an engineering stress at the point of catastrophic collapse reached the astonishing values of 34 GPa and 46 GPa for the smallest faceted particles of Ni and Mo, respectively. The atomistic molecular dynamic simulations of the particle compression demonstrated that the catastrophic plastic yielding of the particles is associated with the multiple nucleation of dislocations at the facet corners or inside the particles. The latter, homogeneous nucleation mode resulted in higher particle strength. The size effect in compression was observed both in the experiments and in atomistic simulations, with smaller particles exhibiting higher compressive strength. We discussed the stronger size effect observed in the experiment (as compared with simulations) in terms of the effect of residual defects trapped in the particles. Finally, we produced Au-Ag core-shell nanoparticles by coating the single crystalline Ag nanoparticles with a polycrystalline Au shell. The core-shell nanoparticles exhibited much lower strength than their single crystalline pure Ag counterparts [8]. We related this decrease in strength with the active role of grain- and interphase boundaries in the polycrystalline Au shell in decreasing the energy barrier for dislocations nucleation.

Bio: Dr. Rabkin was born in Belarus and educated in Moscow, Russia. He obtained his Ph.D. degree in Physical Metallurgy from the Institute of Solid State Physics of the Russian Academy of Sciences in 1991. In the years 1992-1997 he worked at the Max-Planck Institute of Metals Research and the University of Stuttgart, firstly as a Humboldt post-doctoral fellow and then as a University Assistant. Since 1997 he is at the Department of Materials Science and Engineering at the Technion, firstly as Associate Professor (1997-2005) and then as Full Professor (since 2006). In the years 2014-2017 he serves as a Dean of the Department of Materials Science and Engineering, and since 2015 he holds a Trudy and Normal Louis Chair in Engineering. Dr. Rabkin maintains active research collaborations with a number of groups worldwide and he has held several guest researcher appointments abroad: University of Western Australia (Perth, 1997), University of Aix-Marseille (Marseille, 2000), Tohoku University (Sendai, 2003), Princeton University (Princeton, 2005-2006), and Karlsruhe Institute of Technology (Karlsruhe, 2014, 2021). Dr. Rabkin has won several research prizes, such as Otto Hahn medal for young outstanding researchers of Max Planck Society (1994), Federation of European Materials Research Societies Lectureship (1999), and Henry Taub Prize for excellence in research (2004, 2018). He has co-authored about 300 publications in international peer-review journals. His main research interests include diffusion and phase transformations in metals, structure and properties of grain- and interphase boundaries in materials, nanomechanical properties of metals, and hydrogen storage in metal hydrides.