The Iby and Aladar Fleischman
Faculty of Engineering
Department of Materials Science and Engineering

אוניברסיטת תל-אביב
TEL AVIV UNIVERSITY

הפקולטה להנדסה
ע"ש איבי ואלדר פליישמן
המחלקה למדע והנדסה של חומרים

You are cordially invited to attend this seminar to be held on

Wednesday, June 17th, 16:00
Room 103, Engineering Class (Kitot) Building

Morphology and microstructure evolution in Au-Fe bilayers on sapphire

Dr. Dor Amram

Department of Materials Science and Engineering, Technion

A chronological journey through the "life" of a thin bilayer on a substrate (Au/Fe/sapphire) will be presented. There are 3 main "stops" in this journey, each relying on the conclusions of the previous, leading to an applicative research goal – obtaining core(Fe)-shell(Au) nanoparticles (NPs).

i. As-deposited microstructure: we obtained quasi-single-crystalline Au thin films on sapphire, having exceptional crystal quality and thermal stability, by using the Fe layer as a "seed". The seed layer accommodates the large misfit between the Au film and the substrate, which would otherwise result in a typical polycrystalline film.

ii. Anisotropic dewetting: upon annealing at elevated temperatures the films agglomerate ("de-wet") into particles due to poor adhesion between metals and ceramics. The unique microstructure of the films is what lead to a unique dewetting behaviour, which had not been observed before. Our 3D model described quantitatively the kinetics of dewetting in such films, taking into account anisotropy of surface energy and diffusion.

iii. Phase transformations in particles: dewetting of a single-crystalline film results in single- crystal particles. Phase transformations in alloy particles are expected to proceed differently from bulk systems due to the "size effect". We've explored the (1) precipitation of Fe from a Au solid-solution; (2) $\alpha \leftrightarrow \gamma$ transformation in Fe and Fe/Au alloys. Our main conclusion was that, contrary to the current paradigm, phase transformation proceed differently even in sub-micron particles, and not only in NPs. Particularly, Au segregation to all surfaces of Fe particles greatly affected the kinetics and morphology of the transformations.

We capitalized on the latter main result to fulfil the applicative research goal – designing the core-shell NP morphology with a segregated Au layer shell. The ability to bind organic molecules to the NP surfaces was demonstrated, and we explored their magnetic properties. Such NPs may find promising uses in bio-medical, data storage and catalytic applications. Compared to other fabrication methods, we suggested a simple process leading to NPs with a high degree of purity and structural perfection.

Biosketch

Dr. Dor Amram received his B.Sc., M.Sc. and Ph.D. in Materials Science and Engineering from the Department of Materials Science and Engineering at the Technion. His research was performed in Prof. Eugen Rabkin's solid-state thermodynamics group. He received the Acta Materialia Student Award for a paper he published in 2013 concerning phase transformations in micro- and nanoparticles. He received the Fulbright and MIT postdoctoral fellowships for 2015/2016 and will start his postdoc at the Massachusetts Institute of Technology this summer, with Prof. Schuh.