Civil and Environmental Engineering Department
McCormick School
Northwestern University

2013 Seminar Series

Structural Engineering and Infrastructure Materials (SEIM)

Design

Mechanics

History

NORTHWESTERN UNIVERSITY

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Universal Structure-Material-Property Map for Platelet-Matrix Composites

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Dr. Rouzbeh Shahsavari is an assistant Professor at the Department of Civil and Environmental Engineering at Rice University. His research focuses on developing a multi-scale, multi-paradigm materials modeling approach extending from the quantum level to the continuum level to study key functional behavior of complex materials, which are critical to the infrastructure underlying the science and technology enterprises of our society. He completed his Ph.D. at MIT, his Master's at McGill University and his B.S. at Sharif University. Dr. Shahsavari is the recipient of several prestigious awards in both academia and entrepreneurship including Stephen Brunauer award for the best paper in the American Ceramic Society, MIT $100,000 Grand Prize in Entrepreneurship Contest, Silver Medal in Material Research Society, etc.

Natural and synthetic platelet-matrix composites (e.g. bone, nacre, clay-polymer, etc.) exhibit a balance of various mechanical properties (e.g. strength, toughness, and stiffness), which call for a universal measure to quantify this outstanding feature given the structure and material characteristics of the constituents. In this talk, first, I will discuss the origins of load transfer at the subatomic level in polymer-cement nanocomposites, as an example of platelet-matrix composites with geometry and property mismatch across the interface. Next, via developing a generalized elastic framework, a critical dimensionless length parameter will be identified that governs the mechanics of platelet-matrix composites with dissimilar platelets. By deconvoluting this parameter into a 2D diagram representing platelet dissimilarities and characteristic overlap length, I construct a universal diagram that unifies and maps the non-intuitive synergies between structures, materials, and mechanical properties onto a single diagram. Finally, I will discuss the effect of plasticity and comment on innovative strategies for tuning the interplay between geometric constraints, interfacial hydrogen bonding and materials characteristics for an overall optimal mechanical performance of the platelet-matrix composites.

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