UNIVERSITÀ DEGLI STUDI DI BRESCIA

DIPARTIMENTO DI INGEGNERIA CIVILE, ARCHITETTURA, TERRITORIO, AMBIENTE E DI MATEMATICA

Critical Exponents in Random Composites

Dr. Akylkerey Sarvarov

Al-Farabi Kazakh National University, Almaty, Kazakhstan

Institute of Mathematics and Mathematical Modeling

Abstract. The performance of composite materials is strongly influenced by the spatial distribution of reinforcing inclusions. Processing routes such as casting and Friction Stir Processing (FSP) modify the microstructure, leading to changes in effective mechanical and transport properties. This presentation discusses recent mathematical and computational approaches for the characterization of random composites using Fourier analysis and spectral methods.

First, random distributions of non-overlapping inclusions are modeled within a representative volume element (RVE). One-dimensional and two-dimensional Fourier transforms are applied to binary microstructures in order to identify characteristic spatial scales, hidden stochastic periodicity, and clustering effects. The methodology is then applied to real scanning electron microscopy (SEM) images of Al–SiC composites before and after FSP, demonstrating how processing alters the spatial organization of inclusions and the corresponding Fourier spectra.

The presentation also addresses critical behavior in densely packed composites. Recent studies show that critical exponents governing effective conductivity are not universal constants but depend on the protocol used to generate disorder. This protocol-dependent criticality is interpreted as a spectral response of the microstructure to the gradual breaking of translational symmetry.

The proposed framework establishes a quantitative connection between processing, microstructure, spectral characteristics, and effective material properties, providing new tools for the analysis and design of advanced composite materials.

Mercoledì 24 Giugno 2026, ore 11:30

Aula Seminari della Sezione Matematica del DICATAM, Università degli Studi di Brescia, Via Valotti, 9 – Brescia

Per maggiori informazioni contattare federico.zullo@unibs.it