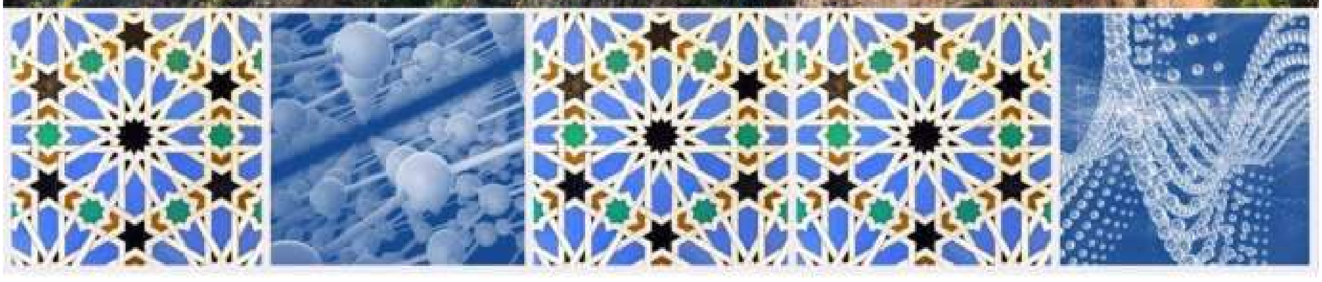
FEMS **2025**
EUROMAT

18th European Congress and Exhibition on Advanced Materials and Processes

Granada, Spain,
14 – 18 September

FEMS EUROMAT 2025
Book of abstracts



Palacio de Congresos de Granada,
Granada (Spain)

Organized by

FEMS – FEDERATION OF EUROPEAN MATERIALS SOCIETIES

sociemat

www.euromat2025.fems.eu

Finite element modeling of effective mechanical properties of multiphase metal matrix composites with various interphase zone

Dr. Szymon Nosewicz[1], Dr. Grzegorz Jurczak[1]
[1]Institute of Fundamental Technological Research of the Polish Academy of Sciences, Warsaw, Poland

Metal–matrix composites (MMCs) are an important class of materials in which the microstructure can be tailored to have superior properties by comparison with non-reinforced alloys. Depending on the manufacturing process, MMC can be more complicated than just a two-phase material combination. Due to solubility and temperature-driven diffusion, another phase is formed between two phases of the composite, which exhibit properties quite different from those of its surroundings. Such interphase plays a critical role in the composite. It may not only modify the physical properties of the composite but also change the quantitative global behavior of the composite material [1].
The proposed research investigates how variations in the plasticity and damage parameters of the interphase influence the effective mechanical properties of a representative volume element (RVE) representing a metal matrix composite (MMC). This study is driven by the understanding that the mechanical properties of the interphase, often not well characterized, can significantly affect the overall behavior of the composite. To explore this, a finite element (FE) model was employed to simulate the composite's effective response, with interphase properties ranging from highly brittle with low ductility and toughness to highly ductile, resembling the matrix material. The numerical simulations were performed on the example of sintered nickel-silicon carbide composite, where the interphase characteristics depend on the manufacturing process. The modeling approach utilized several advanced frameworks:

- The Gurson-Tvergaard-Needleman model for the matrix
- An elastoplastic model with damage for the interphase/particle
- A cohesive zone model for the interface

It shows the significant influence of interphase properties on stress-strain evolution, fracture modes, and effective composite properties - ultimate tensile strength, fracture strain, and toughness. Each composite component's deformation and damage behavior (matrix, interphase, particle, interfaces) has been studied. As the yield stress, hardening curve, and fracture strain of interphase together with interface strength and its fracture energy evolved, more than six fracture modes have been observed, which is the key to the mechanical performance of a complex three-phase system.