

SESSION 1: MODELS AND METHODS, SALON A

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MPFEM simulation on 2D compaction of core–shell particulate composites

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ABSTRACT

The uniaxial die compaction of 2D core–shell (core: SiC; shell: Al) composite powders with different initial packing structures was numerically simulated using DEM (discrete element method) and FEM (finite element method) coupled MPFEM (multi-particle FEM) modeling from particulate scale. The effects of external pressure, initial packing structure, and shell thickness on the packing densification were systematically studied. Various macro- and micro-properties, such as relative density and distribution, stress and distribution, particle rearrangement (e.g., sliding and rolling), deformation and mass transfer, and interface behavior between particles, were characterized and analyzed. The results show that (1) by properly controlling the initial packing structure, thickness of the shell, and die filling conditions, various anisotropic and isotropic particulate composites with high relative densities can be obtained; (2) the whole structure of the final compact is uniform, which can be indicated by the uniform distribution of both relative density and stress; (3) at the early stage of compaction, the mechanism of densification mainly lies in the particle rearrangement. In addition to the sliding, the accompanied particle rolling also plays an important role. With the increase of the compaction pressure, the force network based on SiC cores leads to the extrusion on Al shells between two cores contributing to mass transfer and pore filling; and (4) during compaction, the debonding between the core and shell of each composite particle (mostly occurs at the boundary of the compact or near the large pore structure) appears at the early stage and disappears at the final stage.

KEYWORDS: core–shell structure, Al/SiC composite powder, MPFEM simulation, compaction, debonding