ADVANCES IN MATERIALS PROCESSING: EXPERIMENTAL AND MODELLING ASPECTS

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ABSTRACT

Powder-based materials processing is at the forefront of materials engineering, offering versatile solutions for developing advanced materials with tailored properties. Techniques such as additive manufacturing (AM), spark plasma sintering (SPS), and laser sintering are transforming industries such as aerospace, biomedical, and energy systems by enabling the fabrication of high-performance components with complex geometries.

These processes involve complex multiphysics phenomena, such as powder consolidation, heat transfer, phase transformations, and microstructural evolution. Understanding these mechanisms requires a synergistic approach combining experimental characterization and computational modelling. Advanced modelling techniques, such as DEM, SPH, MPM, are increasingly coupled with FEM and CFD to predict and optimize powder-based processes. Additionally, machine learning is emerging as a powerful tool to accelerate the design and optimization of these systems [1].

This session will explore cutting-edge developments in powder-based materials processing. Experimental insights will include powder characterization and optimization for sintering and additive manufacturing, real-time monitoring techniques for powder behaviour during processing, microstructural evolution and densification during sintering processes (e.g., AM, SPS, flash sintering), and innovations in powder feedstock recycling and reuse. Computational aspect would include coupled multi-physics simulations for powder-based processing (thermal, mechanical, electrical, magnetic, and chemical phenomena), multiscale modelling approaches for linking powder-level phenomena to final material properties, and machine learning applications for powder flow, defect prediction, and process parameter optimization.

REFERENCES

[1] L. Scotti, H. Basoalto, J. Moffat. et al. “Review of Material Modeling and Digitalization in Industry: Barriers and Perspectives”, *Integr Mater Manuf Innov.*, Vol. 12, pp. 397–420, (2023).