San Diego State University

Mechanical Engineering
Faculty Candidate Seminar

Fundamental Research on Sintering Technologies Utilized in Modern Manufacturing of Advanced Powder Materials

Tuesday, March 17, 11am-12pm; EIS Complex, EIS-320

Abstract: Fundamental research on sintering becomes essential for the progress of the modern technologies of field assisted materials processing and additive manufacturing. The presentation provides examples of studies in this emerging area: (i) Analysis of the anisotropy phenomena effecting dimensional precision of sintering processes; (ii) Inverse modeling and validating experimentation for a new controlled interface processing technique combining 3D-printing and spark plasma sintering of powder materials; (iii) Modeling and experimentation on the invented selective sintering technique based on the consecutive binder-jetting and sintering; and (iv) Comparative modeling and experimentation on liquid phase sintering under the influence of gravity and microgravity conditions. To analyze the above-mentioned sintering anisotropy phenomena, the sintering modeling framework based on the mechanism of grain boundary diffusion is extended to take into account the dislocation pipe-enhanced volume diffusion. The reliability and applicability of the developed model is verified by comparing the calculated dislocation densities with experimental outcomes. Major challenges of field-assisted sintering and additive manufacturing include net-shaping and process productivity, respectively. The new controlled interface processing technique combining 3D-printing and SPS of powder materials overcomes these challenges. To ensure the practical implementation of this approach, a comprehensive inverse modeling of the powder material deformation is carried out utilizing the precursors of the machine learning of the outcomes of the controlled interface processing "virtual tests". The invented selective sintering technique integrating binder-jetting and sintering addresses the problems of structural defects in the additive powder bed fusion processes. The final example includes exploring sintering under microgravity conditions as a promising technique for in-space fabrication and repair. This fundamental research is aimed at the in-depth analysis of the liquid phase sintering-induced pore-grain structure evolution and macroscopic shape distortions by the de-convolution of the impact of gravity. These sintering studies have direct applications in bio-medical, computer electronics, wireless devices, automotive, aerospace, defense, and many other areas.

Dr. Elisa Torresani

BIO: Dr. Elisa Torresani received her Ph.D. in Materials Science and Engineering from University of Trento (Italy) in 2016. In 2017, she started her postdoctoral research in the Department of Mechanical Engineering at San Diego State University, where she also teaches a graduate level class on Mechanics of Sintering. Dr. Torresani's research is focused on understanding the fundamentals of sintering and developing constitutive models of sintering which enable the prediction of the macroscopic and microscopic behavior of porous bodies (shape distortion, density distribution, grain growth, etc.) Her current research emphasizes the coupling of experimental and theoretical investigations for a better understanding of the chemical and physical phenomena that drive and influence sintering-assisted additive manufacturing and field-assisted sintering processes. She has authored 19 refereed journal publications and a patent. One of her papers recently published in Metallurgical and Materials Transactions A has been nominated for the Henry Marion Howe Medal of ASM International, awarded to the author of the paper of highest merit published in 2019. Her post-doctoral work on the liquid phase sintering in microgravity has been supported by NASA. She is affiliated with "Society of Women Engineers", "The American Ceramic Society", "The Minerals, Metals, and Materials Society" (TMS) and "American Powder Metallurgy Institute".

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