Joint Condensed Matter and Center for Soft Matter and Biological Physics Seminar

"Rocket Science meets Colloidal Surface Science:
Near-Net-Shaping of Dense and Porous Ultra High Temperature Ceramics for Extreme Applications"

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Date/Time: *Monday, 9 September 2019, 4:00pm-5:00pm*

Location: *304 Robeson Hall*

Abstract: Ultra High Temperature Ceramics and other non-oxide ceramics represent the best candidate materials for use in extreme applications, including components for hypersonic vehicles, personal armor devices and cathodes for aluminum smelting and lithium air batteries. However, most of these applications require either a very complex geometry or very high and intricate porosity which cannot be achieved or designed using the current state-of-the-art for these types of compounds. The colloidal powder processing approach seems the natural answer to this problem, since it allows the preparation of high and uniform green density bodies facilitating densification, to control the porosity and the preparation of near-net-shaped dense and porous components, while minimizing defects and flaws through the preparation of ceramic powder suspensions.

In this presentation***, two cases studies*** related to hypersonic applications are discussed: The first one comprises the preparation of ***dense ultra-high temperature ceramics for leading edges in hypersonic vehicles*** by using the combination of colloidal processing and pressure less sintering. The second case study focused on the preparation of ***multi-scale porous materials for ultra-high temperature insulation***. Highly porous UHTC materials have been produced by four different processing routes. The exhaustive control of the forces between particles and understanding the interaction between additives and powder surfaces have been key in developing highly porous ZrB_2 and TiB_2. The relationship between ***microstructure and properties*** of these materials was elucidated by the ***3D image reconstruction and predictive modelling*** via a combination of x-ray tomography and simulations, which are validated against experimental values at room temperature. These models can be used to simulate and predict the thermal and mechanical properties of the materials under relevant extreme environment conditions.

Bio:

Dr. Carolina Tallon is an Assistant Professor at the Materials Science and Engineering Department, at Virginia Tech in January 2016. Apart from her appointment with this Department, she is one of the 7 members of Advanced Manufacturing Team of the College of Engineering at Virginia Tech.

Dr. Tallon completed her undergraduate degree in Chemical Engineering at the University of Granada (Spain) and received her PhD in Inorganic Chemistry at the Institute of Ceramic and Glass and the Universidad Autonoma in Madrid (Spain). She went to Australia in 2008 to undertake post-doctoral research developing ceramic materials for advanced defense applications. Since then she contributed to the research and teaching in the School of Engineering of the University of Melbourne, where she was a Lecturer (Teaching and Research) in the Department of Chemical and Biomolecular Engineering, and the Academic Convener of the Hallmark Materials Research Initiative. Her research interest focuses on ceramic processing, near-net-shaping, multi-scale porous materials, ultra-high temperature ceramics, armor materials, microstructure-properties modelling, rheology and colloid surface science. She has published 25 articles in international peer-reviewed journals, 2 book chapters, and has participated and contributed to more than 60 academic and technical presentations in conference and symposiums. Dr. Tallon was one of the 12 Australian Fresh Scientists in 2012 and she was part of the research group who won the prestigious Land Defense Australia National Industry Innovation Award in 2014 and CRC Innovation Award in 2015. She was the Chair of the 3rd conference in the series "Ultra High Temperature Ceramics: Materials for Extreme Environment Applications III" in 2015 and she is one of the co-chairs for the 5th conference of these series in 2020.