National Institute of Technology Rourkela

## Defence Seminar

Seminar Title : Processing-Microstructure-Mechanical Properties of Freeze-cast Porous Alumina Scaffolds with 3-Levels of Structural Hierarchy

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Venue : CR Seminar Room [Hybrid mode: Link: https://meet.google.com/srj-kqwf-wgf]

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Abstract : Porous materials fabricated by novel freeze-casting technique has potential application in various fields like filters, biological scaffolds, electrodes for SOFC etc. However, this wide diversity in applications demand large-scale ordered porosity with controlled pore morphology. In the quest of developing such materials, control of several processing variables is utmost necessary. The present research focuses the in-depth investigation on the effect of solid loading (10-40 vol%), alumina platelet size (4 and 8 µm) and wide range of freezing velocity (1.4-2600 µm $s^{-1}$) on the microstructure of sintered freeze-cast porous alumina scaffolds. Unidirectional freeze casting was carried out under large vertical temperature gradient in a custom-built setup. A microstructural montage was presented to delve into the freezing induced microstructural evolution along the ice-growth direction for both smaller (4 µm) and bigger (8 µm) size platelets scaffold. The ensemble of micrographs presented indicate the influence of processing variables on the transition between platelet rejection and engulfment by the ice lamellae. This corresponds to the microstructural transition of either (a) lamellar-dendritic-isotropic (more accurately dendritic overlayer structure) or (b) lamellar-isotropic (precisely lamellar overlayer structure). Based on a dimensionless morphological parameter *m*, the morphologies were categorized into lamellar (*m*>4), dendritic (2<*m*<4) or isotropic (*m*<2). The specific processing conditions that yielded different morphologies and the parameter *m* were presented together in the form of a &lsquo*3D morphology map*&rsquo to establish the processing-microstructure relationship. Further, the compressive mechanical response of the highly porous (> 85%) freeze cast platy-alumina scaffolds (Level-1 hierarchy) exhibiting different pore morphologies i.e. lamellar, dendritic and isotropic, were examined in the quasistatic regime of strain rate (~$10^{-4}$ $s^{-1}$) in order to establish the microstructure-mechanical property relationship. A unique strategy was employed by adding silica-calcia liquid phase sintering aid and submicron sized alumina particles to create structural hierarchy of Level-2 and 3 respectively. This resulted an extraordinary improvement (~2 orders of magnitude higher) in both strength and stiffness of the resultant freeze-cast porous alumina scaffolds.