PROCESSING OF UHTCMCS WITHIN C3HARME

Jon Binner, University of Birmingham, UK;
j.binner@bham.ac.uk
V Rubio, University of Birmingham, UK;
D Sciti, Institute of Science and Technology for Ceramics, Faenza, Italy;
L Silvestroni, Institute of Science and Technology for Ceramics, Faenza, Italy;
F Monteverde, Institute of Science and Technology for Ceramics, Faenza, Italy;
A Vinci, Institute of Science and Technology for Ceramics, Faenza, Italy;
L Zoli, Institute of Science and Technology for Ceramics, Faenza, Italy;
M Parco, Technalia, San Sebastian, Spain;
T Reimer, D Koch, DLR, Stuttgart, Germany;
A Schoberth, Airbus Group Innovation, Munich, Germany;
Sebastian Heilmeyer, Airbus Group Innovation, Munich, Germany;
S Sanvito, Trinity College Dublin, Ireland
Y Zhang, Trinity College Dublin, Ireland

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There is an increasing demand for advanced materials with temperature capability in highly corrosive environments for aerospace. Rocket nozzles of solid/hybrid rocket motors must survive harsh thermochemical and mechanical environments produced by high performance solid propellants (2700-3500°C). Thermal protection systems (TPS) for space vehicles flying at Mach 7 must withstand projected service temperatures up to 2500°C associated to convective heat fluxes up to 15 MWm^{-2} and intense mechanical vibrations at launch and re-entry into Earth's atmosphere. The combination of extremely hot temperatures, chemically aggressive environments and rapid heating/cooling is beyond the capabilities of current materials.

As indicated by the previous talk, the main purpose of C3HARME is to design, develop, manufacture, test and validate a new class of out-performing, reliable, cost-effective and scalable Ultra High Temperature Ceramic Matrix Composites (UHTCMCs) based on C fibre preforms enriched with ultra-high temperature ceramics (UHTCs) and capable of in-situ repairing damage induced during operation in severe aerospace environments. Two main applications are envisaged: near-ZERO erosion rocket nozzles that must maintain dimensional stability during firing in combustion chambers, and near-ZERO ablation thermal protection systems enabling hypersonic space vehicles to maintain flight performance.

This talk aims at providing an indication of progress to date within Work Package 2, which is focused on the processing of C_f-ZrB_2 UHTCMCs. Four primary routes are being investigated, these include: green forming of fibre reinforced UHT ceramics followed by spark plasma sintering; radio-frequency enhanced chemical vapour infiltration of UHTCMCs; reactive melt infiltration of UHTCMCs and polymer infiltration and pyrolysis of UHTCMCs. All four approaches will be outlined and conclusions drawn, plus there will be a brief mention of ongoing work into atomistic modelling of processes at materials interfaces and nanoparticle dispersion with a view to imparting self-healing properties.

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