Employment of High-Frequency Electro-Magnetic Technologies for Competitive Processing of Ceramic Matrix Composites and Graphite Expansion

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Advanced ceramic materials, such as non-oxide ceramic matrix composites (CMCs) carbon (C) or silicon carbide (SiC) fibre reinforced composites, represent the most promising solutions for high temperature applications in the manufacturing industry, in the transportation sectors and for new electro technical applications. Expanded graphite (EG) has also attracted market attention, as it outperforms not expanded graphite and other conductive fillers in terms of thermal and electrical conductivity. New solutions based on the application of microwaves and radio frequencies were exploited in the projecting and building of specific laboratory plants, involving four different processes: chemical vapour infiltration (CVI), Liquid Silicon Infiltration (LSI), graphite expansion (GE) and polymer impregnation and pyrolysis (PIP). Microwave (MW) radiation has been used as an alternative to conventional radiant heating techniques in CVI processes to produce SiCf/SiC components [1-2], showing that fabrication times can be dramatically reduced. LSI could benefit from MW processing because of the higher heating rates resulting in reduced cycle times, limiting energy consumption and costs, and in thermally induced cracks in the material. MW heating has already been proven to be effective at lab scale in expanding graphite, resulting in an expanded material whose properties are at least as good as those of the standard thermally expanded product [3]. The PIP process involves soaking the fibre preform with a liquid polymeric precursor, which is cured and then pyrolyzed, converting the polymer into ceramic. The integration of the MW and/or RF technologies to CVI, LSI, GE and PIP allowed to design and assemble innovative prototypal plants of the different technologies, that are being scaled up, with the objective to make them easily engineered and marketable.

References

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