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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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CARBON/CARBON COMPARATIVE OPTIMIZATION METHOD FOR HOT STRUCTURES APPLICATIONS IN RE-ENTRY ENVIRONMENT CONDITIONS

Abstract

Hot structures applications have becoming more and more widespread, from space to nuclear sectors. The development of reusable launch vehicle (RLV) and hypersonic vehicles must include a significant reduction of the payload transportation costs. One of the most expensive systems is the thermal protection system (TPS), which protects the vehicle from the high thermal loads during re-entry. C/C is one of the best materials for hot structures. It has good characteristics, particularly adapted to operate in re-entry environments with high resistance, high elongation modulus, high mechanical property at high temperature and very low CTE. The key factor for using this kind of material is the high stability at high temperature, preserving its mechanical properties. Here is presented a mathematical model for C/C production which is optimized by a genetic algorithms. To provide the experimental-and computational verification and if necessary the corresponding correction of the model under consideration the inverse method is used. Such approach permits to perform the parametric and structural identification of the model. These procedures are presented including both experimental investigation and methodical aspects. Special test equipment and the regularizing algorithm for solving the ill-posed inverse heat conduction problem are briefly described. Genetic Algorithms (GAs) are a family of computational models inspired by evolution. These algorithms encode a potential solution to a specific problem on a simple chromosome-like data structure and apply recombination operators to these structures so as to preserve critical information. This mechanism allow to look for the best solution of the problem, and so they are used as function optimizers in a wide range of problems with multi-dimension function. The use of genetic algorithms let the process be optimized acquiring different choices of production parameters. Controlling time and temperature of the pyrolysis process will allow to obtain the minimum number of pyrolysis cycles. The infiltration process is performed in order to obtain the best permeation of the resin in the C/C composite.

Requirements of C/C for re-entry conditions is to have a low heat conductibility and at the same time high mechanical performances. These characteristics can be correlates to the final density of the composite and so to its infiltration level. Studies on correlations between density and mechanical and thermal properties shows that higher is the density, higher are the heat conduction and mechanical properties, vice versa, lower density brings higher heat capacity but the mechanical properties will be less satisfying...