Ceramic nanocomposites: 1. Thermal shock resistant and flame retardant ceramic nanocomposites (Woodhead Publishing Series in Composites Science and Engineering)

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This chapter discusses the performance behaviour of ceramic nanocomposites under conditions of thermal shock, i.e. when they are subjected to sudden changes in temperature during either heating or cooling or may be in flame propagating zones. For example, during emergency shut-downs of gas turbines, cool air is drawn from the still spinning compressor and driven through the hot sections: the temperature at the turbine outlet decreases by more than 800°C within one second and ceramic nanocomposite materials are an appropriate choice for such application. Furthermore, such a situation may arise about 100 times during the lifetime of a modern gas turbine engine. Similarly, in the nuclear industries, apart from the moderate shocks inflicted during start-up and shut-down of the system, the plasma-facing material can suffer rapid heating due to plasma discharge. Thus, when a body is subjected to a rapid temperature change such that non-linear temperature gradients appear, stresses arise due to the differential expansion of each volume element at a different temperature. The design principles for the fabrication of high-performance thermal shock resistant ceramic nanocomposites with improved mechanical properties are highlighted in this chapter. Moreover, the pertinent factors such as interface characteristics, densification methods, superplasticity and the role of nano-size particulate dispersion, which are responsible for the development of thermal shock resistant and flame retardant nanoceramic materials, are addressed and reviewed. Various test methods for the characterisation and evaluation of ceramic nanocomposites are described. Finally, the new concept of materials design for future structural ceramic nanocomposites is discussed for safe applications in high-temperature thermal shock zones.

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