MECHANISM FOR ABNORMAL THERMAL SHOCK BEHAVIOR OF MAX CERAMICS

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ABSTRACT

Ceramics should possess a good thermal shock resistance when subjected to sudden changes of temperature (thermal shock). However, most ceramic materials are susceptible to thermal shock with catastrophic drops in mechanical properties, limiting their wide applications.

Recently, it has been found that some layered ternary carbides and nitrides (also called MAX phases, M denotes an early transition metal, A is a mostly IIIA or IVA group element, and X is either C or N) exhibit abnormal thermal shock behaviour. The residual strength of the as-quenched MAX phases gradually decreases without catastrophic failure with increasing quenching temperatures and then unbelievably increases after quenching at certain temperatures, not like other ceramics showing catastrophic drops in mechanical properties. Although the abnormal thermal shock behaviour has been found in some MAX phases over 15 years, yet the real mechanism is not entirely clear. Up to now, several mechanisms have been proposed for the abnormal behaviour. However, the above mentioned mechanisms are speculative and have never been directly confirmed by experiment evidence.

To reveal the main mechanism for the unusual thermal shock behaviour, we chose a Cr_2AlC ceramic as a representative member of the MAX phases and performed thermal shock test in a quenching temperature range of 800-1300 °C. The main mechanism for the abnormal thermal shock should be attributed to crack healing, i.e. the thermal shock induced cracks are instantly healed by the formation of reactants well adhering to the crack faces during quenching.