CRACK HEALING BEHAVIOUR OF A Cr_2AlC CERAMIC

S.B. Li[1,2], L.O. Xiao[1], G.M. Song[2], X.M. Wu[3], W.G. Sloof[2], S. van der Zwaag[3]

[1]Institute of Materials Science and Engineering, School of Mechanical and Electronic Control Engineering, Beijing Jiaotong University, Beijing 100044, China.
Email: shbli1@bjtu.edu.cn
[2]Department of Materials Science and Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, The Netherlands.
Email: g.song@tudelft.nl
[3]Faculty of Aerospace Engineering, Delft University of Technology, Kluyverweg 1, 2629 HS Delft, The Netherlands.
Email: S.vanderZwaag@tudelft.nl

Keywords: Crack-healing, Cr_2AlC, Mechanical property, Healing mechanism, Microstructure.

ABSTRACT

MAX phase materials exhibit a combination of attractive properties [1-4]. They have a high strength and yet are relatively ductile. The materials have a good electrical and thermal conduction. Due to their oxidation and corrosion resistance as well as to thermal shock resistance, they can be used at high temperatures and in aggressive environments. Recently, MAX ceramics like Ti_3AlC_2[5] and $Zr_2Al_4C_5$[6] were shown to exhibit another attractive property, namely: crack healing upon exposure to high temperatures. While the degree of healing of healing in these grades of MAX ceramics was shown to be rather high, it seems likely that the presence of either weak TiO_2 or weak ZrO_2 in the oxide filling the crack, must have a negative effect on the healing efficiency. Hence in this work we explore the healing efficiency of another MAX ceramics, Cr_2AlC, for which both oxides Al_2O_3 and Cr_2O_3 are expected to have a high strength at elevated temperatures.

To this aim, in the present study, a dense and fine-grained Cr_2AlC ceramic (~ 2 μm) was produced by mechanically activated sintering; see Fig.1. Its crack healing behaviour as a function of temperature, healing time and crack size was studied quantitatively. This ceramic is able to heal indentation-induced cracks in the range of 0.3-2.5 mm when exposed to 1100 ºC for 4 hours in air; see Fig.2. The main crack-healing mechanism is that cracks are filled by the formation of oxide, α-Al_2O_3, with minor amounts of Cr_2O_3. Cracks before and after healing were characterized by scanning electron microscopy and X-ray tomography. The compositions in the crack-healed zones were analyzed by X-ray diffraction and electron probe micro analysis (EPMA). The healing efficiency of the Cr_2AlC ceramic compared favourably to that of MAX ceramics studied earlier.

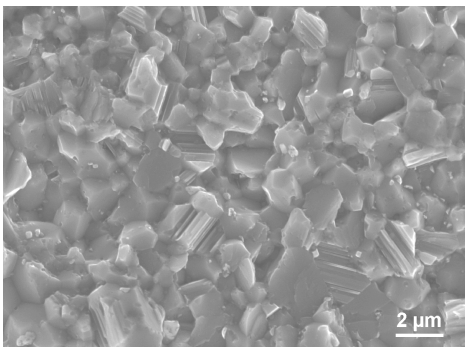

Figure 1: Microstructure of a fine-grained Cr_2AlC

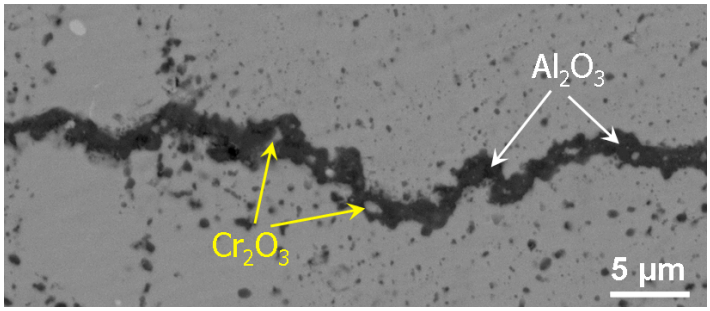

Figure 2: Backscattered electron image of the healed crack after healing at 1100 °C for 4 h. The indentation induced crack was healed by the formation of α-Al_2O_3 with minor amounts of Cr_2O_3.

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