

## ELECTROCHEMICAL HEALING OF MAX PHASE CERAMICS

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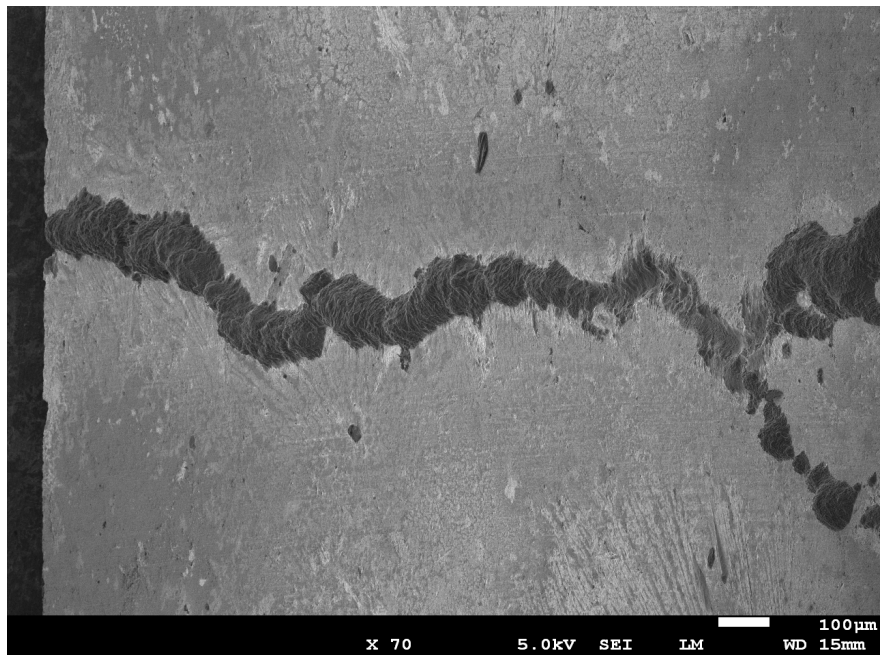
### ABSTRACT

Earlier work [1] has shown that metallo-ceramic MAX phase materials, such as  $Ti_3AlC_2$ , not only have very attractive properties, combining those usually attributed to metals and those attributed to ceramics, but also display self healing properties when exposed to high temperatures. The restoration of the tensile strength is due to the formation of an oxidic residue, in particular well-adhering  $Al_2O_3$  and loosely-bound  $TiO_2$ , within the crack zone leading to quite adequate load transfer. However this healing mechanism does not operate below typically 1173K in realistic times because of low oxidation rates.

In this work we present a novel approach to heal the cracks on Ti-Al-C ceramic samples at ambient temperatures. The approach is based on inducing localized electrochemical reactions in the crack zone using various types of aqueous solutions and DC voltammetry. In the presentation we will present the initial results on this new mode of inducing electrochemical healing and will compare the morphology and composition of the electrochemical products with that created by oxidative healing.

The electrochemical response of the  $Ti_2AlC$  sample to various DC voltammetry was investigated in 3.5% NaCl solutions, 16.35%  $H_2SO_4$ , or 10.6%  $Na_2CO_3$  solutions. In all the experiments The MAX phase served as the working electrode, Pt mesh as the counter electrode, and saturated Ag/AgCl as reference electrode.

The results obtained from potentiostatic polarisation of the MAX sample in 1M  $Na_2CO_3$  at 2V versus Ag/AgCl reference for 2 hours showed that a surface crack was fully filled with a white deposit from the electrolyte (Figure 1). However, healing the crack needs this deposit to be adhered to the substrate materials and our previous results showed the best way to achieve this strong overlap is by using a filling material that is produced from the substrate materials [1]. For that purpose, the MAX sample was subjected to anodising process in  $H_2SO_4$ -based solution. The results showed that attacking the MAX sample surface by the electrolyte solution to form filling materials from the bulk substrate is possible in the presence of chloride ions in the electrolyte at temperature higher than 332K. More research into the optimal composition of the electrolyte and the imposed potential to fill the crack with a load bearing deposit is required, yet the approach seems promising.



**Figure 1: filling the crack on the surface of MAX by anodic polarisation in 1M Na<sub>2</sub>CO<sub>3</sub>**

#### REFERENCES

- [1] Song, G, Pei, YT, Sloof, WG, Li, SB, Hosson, ThM & Zwaag, S van der (2007). *Oxidation-induced crack healing in Ti<sub>3</sub>AlC<sub>2</sub> ceramics*. Scripta materialia, 58, 2007, p. 13-16