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Characterization of the microstructure, wear resistance and corrosion resistance of the Alloy 625-based composites

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INTRODUCTION & AIM

Ni-based superalloy 625 (Inconel 625/IN625), which is used in aerospace and supercritical water reactors due to its stability and high corrosion resistance. Conversely, the alloy's low hardness and wear resistance makes it unsuitable for severe abrasion and hot corrosion applications, like tip blade repairs. This opens the door for the use of metal matrix composites (MMCs), which have excellent mechanical and physical performance even at high temperatures, for refractory, abrasive, and structural applications. Inconel 625-based MMC matrices have been fabricated by incorporating various ceramic phases, such as carbides (NbC, SiC), oxides (Al_2O_3, Y_2O_3), and diborides (TiB_2). Manufacturing MMCs inevitably brings about challenges, such as reinforcement/matrix interfacial cracking, uneven reinforcement distribution, and their segregation at grain boundaries, all of which can affect the final mechanical properties of the fabricated parts. To fabricate ceramic-reinforced MMC coatings, a commonly utilized technique is the introduction of a sufficiently high amount of ceramic particles into a metallic matrix or molten pool, typically prepared through an ex situ process. A very promising and effective method for rod manufacturing is suction casting, however, a significant research gap remains regarding its application to composite materials. Therefore, a systematic investigation of TiC-strengthened MMCs fabricated via suction casting is necessary. The present study aims to analyze the effect of TiC on the as-cast microstructure and selected physicochemical properties of Alloy 625-based nanocomposites processed via suction casting.

METHOD

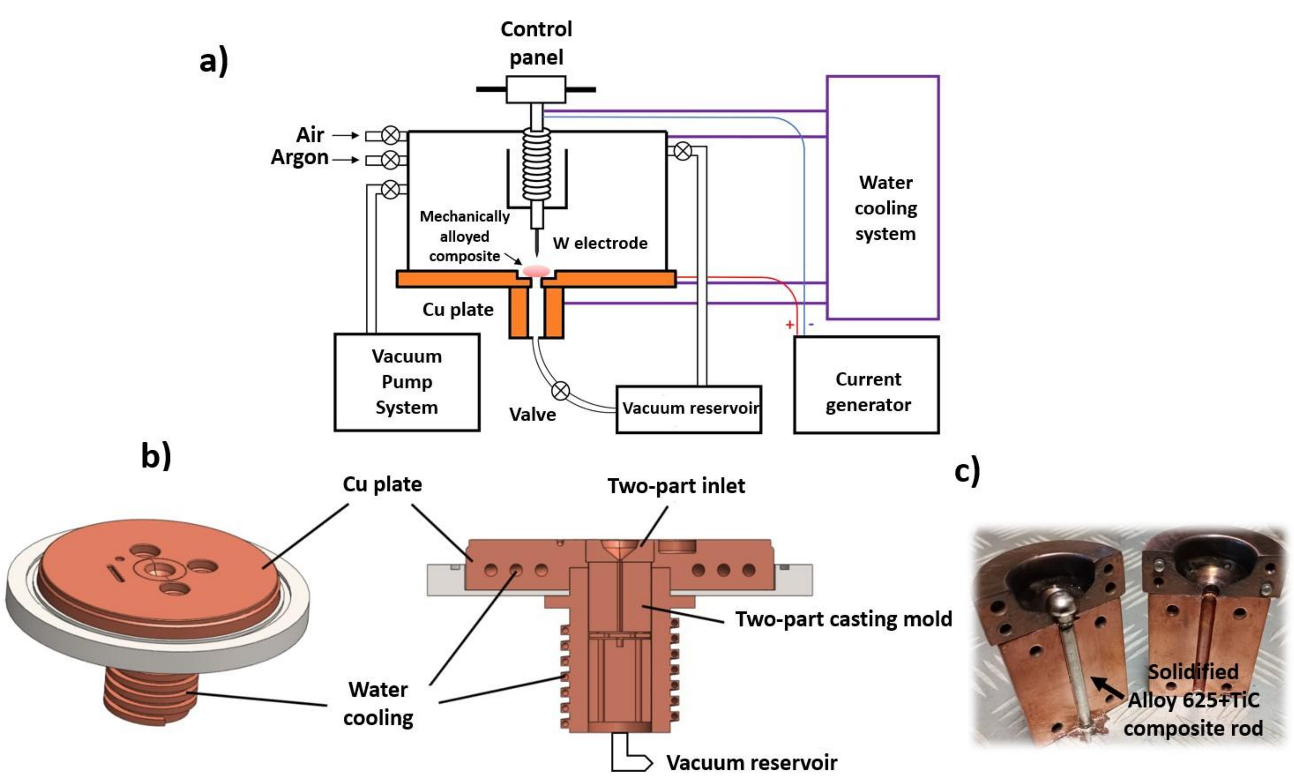

Fig. 1. a) scheme of the suction casting device; b) 3d model of mold; c) solidified composite for further investigation

RESULTS & DISCUSSION

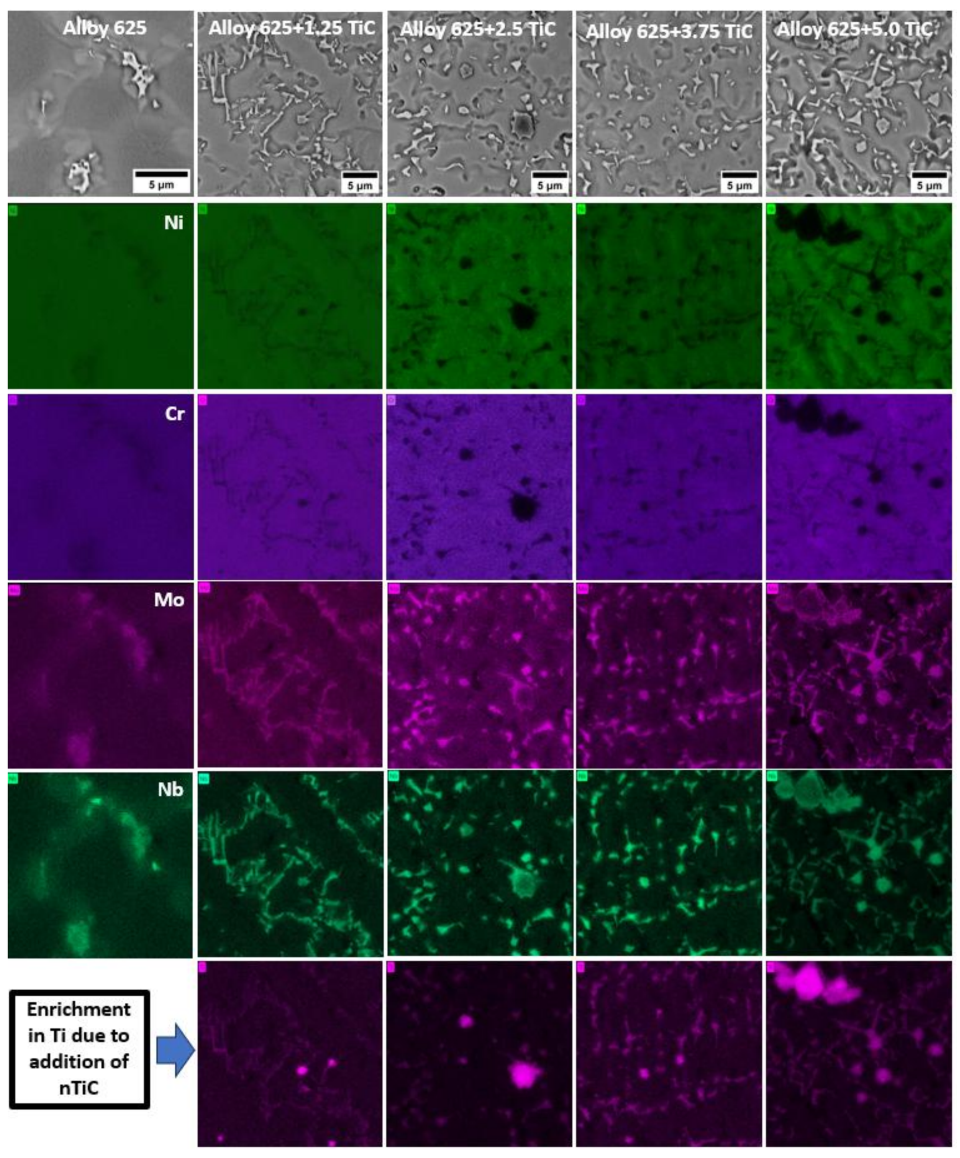

Fig. 2. Distribution of selected alloying elements in the Alloy 625 and Alloy 625+TiC nanocomposites

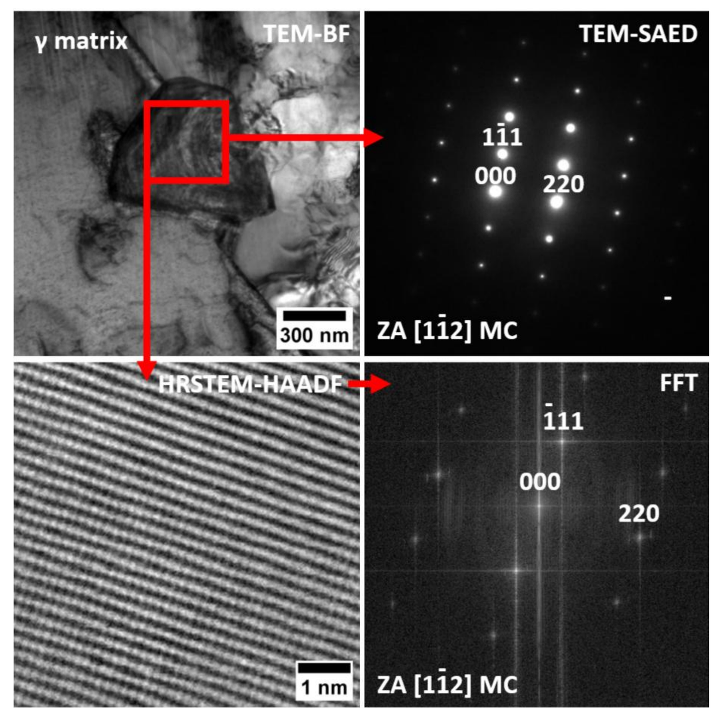

Fig. 3. Microstructure and nanostructure of matrix in a dendritic region with corresponding TEM-SAED pattern and FFT. Lack of peaks originating from the γ' or γ''

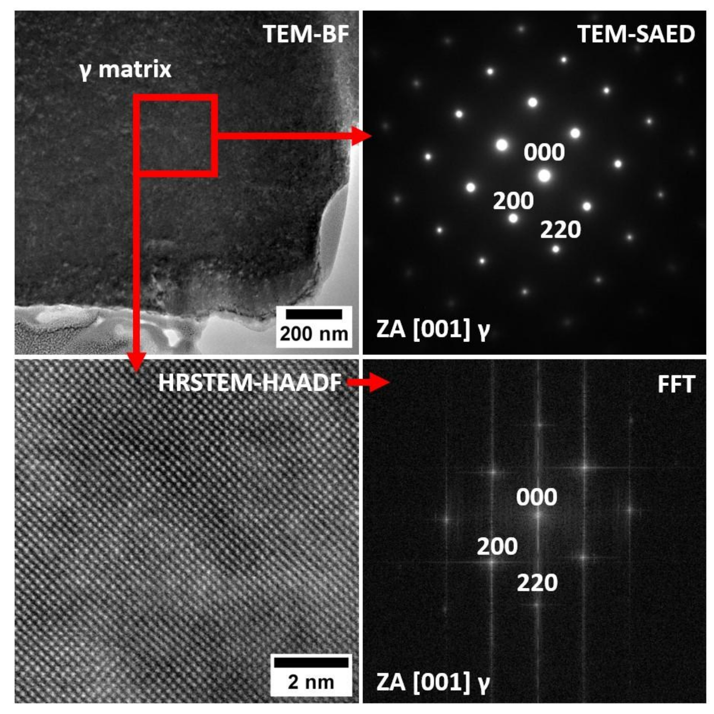

Fig. 4. Microstructure and nanostructure of the MC carbides with corresponding TEM-SAED pattern and FFT

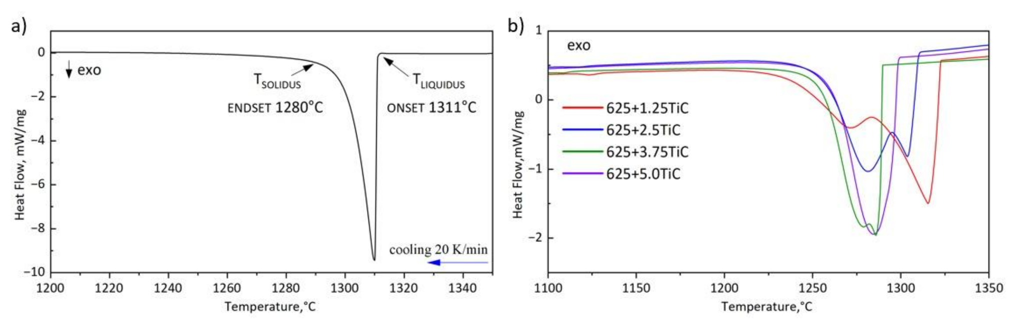

Fig. 5. The DSC experimental curve of the: a) Alloy 625; b) Alloy 625+TiC composites registered during cooling

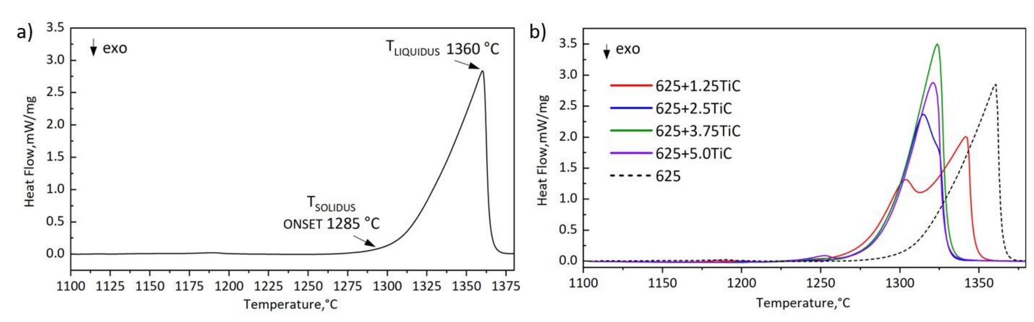

Fig.6. The DSC curve of the: a) Alloy 625; b) 625+TiC composites registered during heating

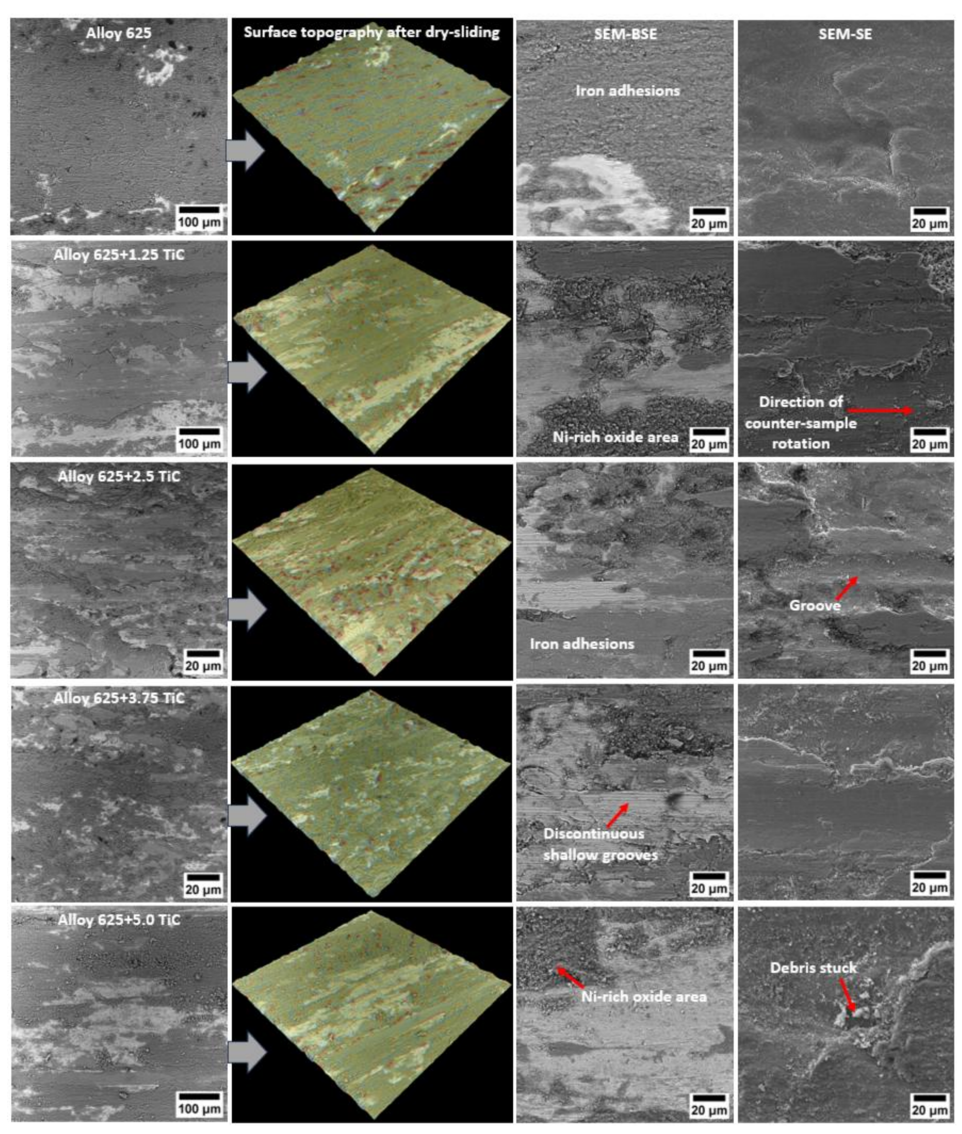

Fig. 7. Morphology of the Alloy 625+TiC composites' surface after wear resistance test

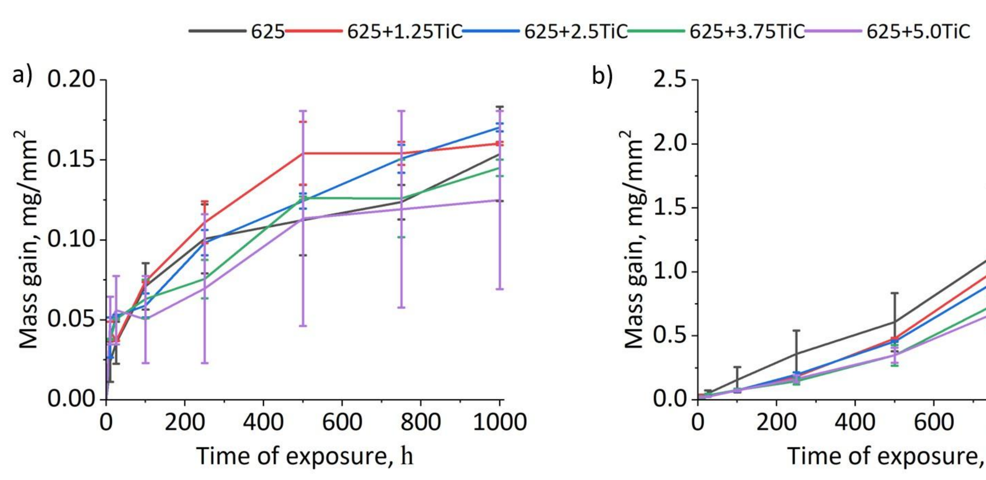

Fig. 8. Mass gain after: a) steam oxidation; b) hot corrosion

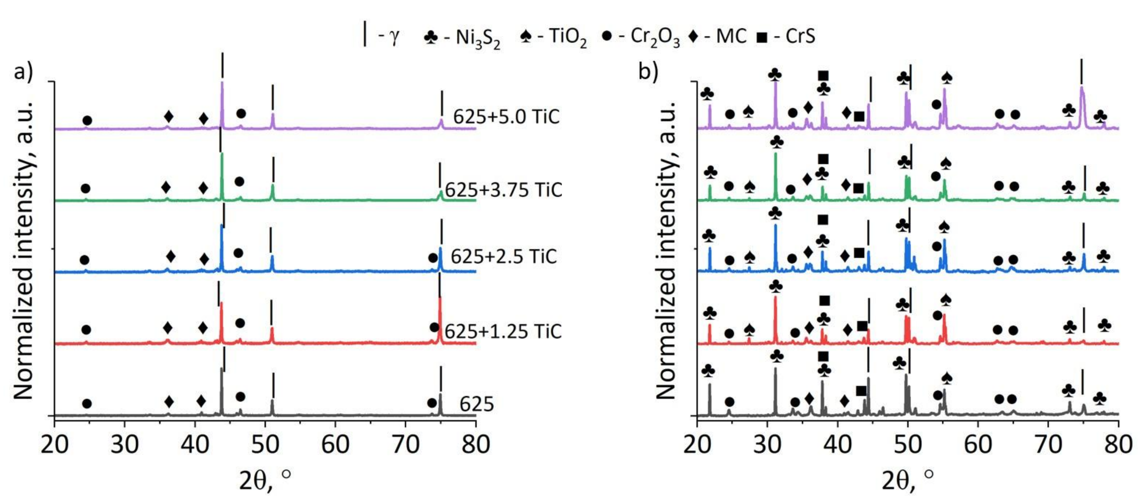

Fig. 9. XRD of the oxide-scales after oxidation in: a) steam oxidation; b) Ar+0.25 SO_2 gas mixture

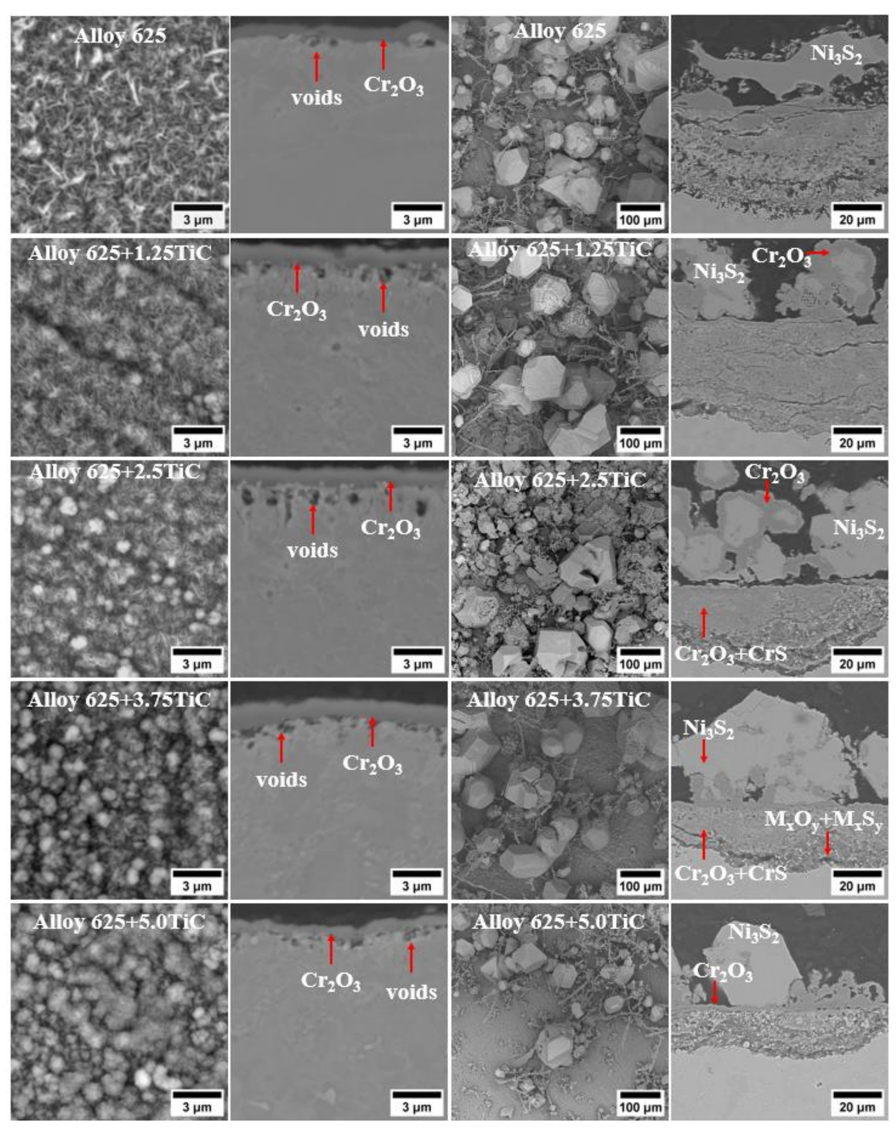

Fig. 10. Morphology of the oxide scale after steam oxidation (left side) and exposure to the Ar+0.25 % SO_2 gas mixture (right side) at 704 °C for 1000 h.

NCBR National Centre for Research and Development

LIDER

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