Type of presentation: Poster

MS-4-P-3421 Transmission electron microscopy and X-ray diffraction studies of Ni-W/ZrO_2 metal-matrix composites

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Studies on preparation and microstructure-property relationship of particle reinforced metal-matrix composite (MMC) coatings are of fundamental importance mainly due to the potential breakdown of classical scaling laws and the accompanying demands for advanced materials of physical properties in the nanostructured limit. With the emergence of nanostructured materials, electrodeposition techniques have been widely applied to obtain a variety of new nanomaterials, including nanocomposites of enhanced mechanical properties [1]. Such MMC coatings could be relevant for many technological applications like thermo-resistant, hard-wearing materials [2] and as important alternatives to hard chromium coatings. Electrodepositited composites containing hard ceramic particles incorporated into a Ni-W alloy matrix has been the subject of few papers [3,4], but none was related to the Ni-W/ZrO_2 system.

The sample structural features were investigated using X-Ray diffraction and high-resolution transmission electron microscopy (HRTEM), high-angle annular dark-field scanning transmission electron microscopy (HAADF STEM), in combination with electron energy loss spectroscopy (EELS) and energy dispersive X-ray spectroscopy (EDX) at nanometer scale.

A detailed characterization on the structural and chemical composition of ZrO_2 nanoparticles embedded in a Ni-W supersaturated alloy matrix of about 10 nm grain size is presented. As seen in Fig. 1. deposited composite material was crack free, compact, and well adherent to the steel substrate. We report structural and compositional inhomogenities found in the Ni-W matrix, where the local changes in Ni-W alloy composition were found to reach 10 wt%. EDX results exemplified in Fig. 1a show tungsten segregation/enrichement in between the ceramic nanoparticles regions, being consistent with complementary EELS data. In addition, changes in the O K edge was observed at the surface of the ZrO_2 particles.

These observations, complemented by microhardness, wear and corrosion resistance tests, allow for detailed understanding of tungsten-based alloy and composite systems functional properties.

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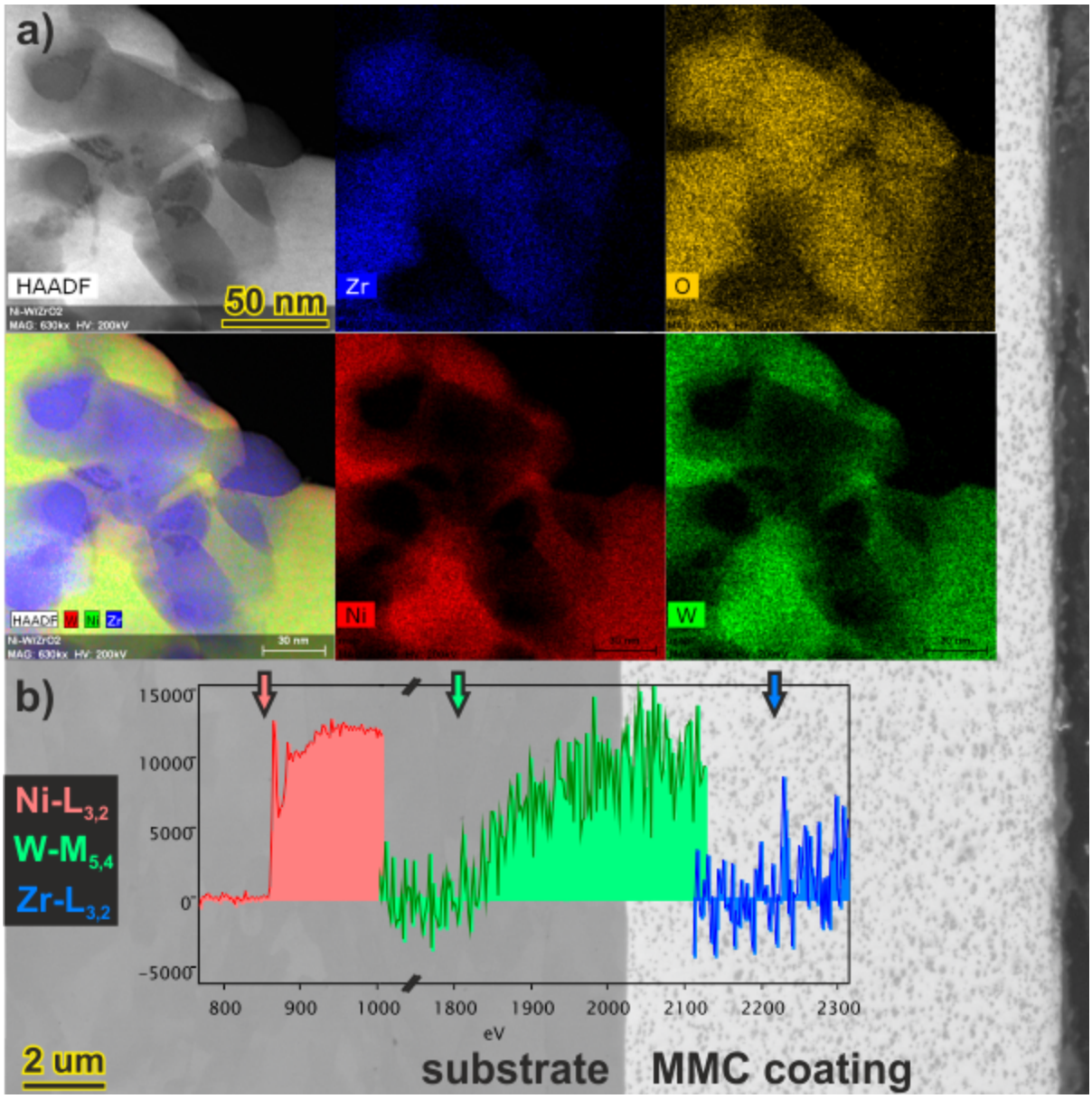

Fig. 1: In the background SEM BSE overview image of the Ni-W/ZrO_2 MMC deposited on a steel substrate,(a) STEM HAADF overview image and EDX color maps of the system, showing the Zr, O, Ni and W distribution, notice different Ni/W repartition, (b) EELS signal of Ni (Ni-$L_{3,2}$ edge 855 eV), W (W-$M_{5,4}$ edge 1809 eV) and Zr (Zr-$L_{3,2}$ edge 2222 eV).