Experimental Phase Investigations for the WnM Project

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Objective of the WnM project is the development of wear-resistant laser hard-coatings. Laser hard-coatings allow a targeted adaption of the surface, for example of slide rings and sealings, for pronounced abrasive stresses. During the laser melting process of different powder alloy components, phase transformations are occurring which leads to the formation of varying transformation carbides of high hardness in the ductile matrix. Besides the possibility of a tailor-made alloy design, this technique allows an economic treatment of the used resources because the selection of cheap powder-based alloys may lead to the formation of valuable reaction products. For the realization of these laser hard-coatings, iron-based alloys with a high amount of Cr, Ni and Mn in the combination with V, W and Ti as carbide formers are promising. In addition, Al and Si are added to improve the oxidation resistance. The resembling powders are applied to slide rings by using the R:LM²-technology by the project partner KSD GmbH.

In first studies, samples with hard-coatings manufactured by using powders consisting of FeV, Cr_2C_3 and a Ni amount between 5 and 25 wt.-% are investigated. The samples were ground, polished and analyzed by means of light microscopy, scanning electron microscopy (SEM) in combination with energy-dispersive X-ray spectroscopy (EDX), automated back scatter diffraction (EBSD) and focused ion beam milling (FIB), as well as micro hardness measurements. In all samples, three areas may be identified as (i) the layer-substrate interface, (ii) the mid area of the layer, and (iii) the near-surface area of the layer, with the formation of characteristic phases, respectively. These areas also differ noticeably with respect to the tested micro hardness: in the areas (ii) and (iii), the micro hardness has the highest value and significantly decreases in area (i) towards the substrate. In all areas, the occurrence of the anticipated transformation carbides becomes obvious, although their appearance is mostly pronounced in area (iii) which results in the high values for the micro hardness. Besides the formation of hard phases, characteristic flower-like precipitates are mainly found in area (ii) which are identified by the EBSD technique to consist of VCr_2C_2. In all areas, the formation of an eutectic microstructure is observed as well.

Regarding the aims of the WnM project, the performed investigations and phase identifications play an important role: they will serve to build up a thermodynamic database and, finally, to create a software tool for computerized material development.