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Characterization of Ni-B/MoS_2 composite coatings produced by chemical reduction method using sediment deposition technique

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INTRODUCTION

Since chromium (VI) compounds are on the list of dangerous substances with cancerous effects and are being withdrawn gradually, the search for alternatives continues unabated. Therefore, a lot of research and work is being done to develop substitutes for chromium (VI) compounds. Within this stream, an attempt was made to develop composite coatings with a matrix of nickel-boron (Ni-B) alloy and embedded soft-phase nanopowder MoS_2 particles for use on components in the automotive and/or aerospace industries. The choice of the Ni-B alloy matrix material is based on its properties (hardness of about 800-900 HK0.025) and its potential use as a replacement for chromium coatings.

EXPERIMENTAL

Composite coatings Ni-B/MoS_2 were produced using sediment deposition technique and were deposited from a bath at different concentrations of dispersion phase, namely 0.1; 0.3; 0.5; g/dm^3. Molybdenum sulfide in the form of powder (<90 nm) was used as a dispersion phase. The deposition process was carried out at a temperature of 90 °C for 1.5h. The dispersion phase was properly pre-treated and purified before being placed in the bath. Characterization of the structure of the produced materials was performed using X-ray diffraction analysis. Surface morphology and topography were examined using the scanning electron microscopy (SEM). Thickness of obtained coatings was examined using X-ray fluorescence spectrometry. As well as mechanical properties of obtained coatings were determined by Depth Sensing Indentation (DSI) method. Adhesion of the produced coating to carbon steel substrate was tested by scratch test method. Results of research on composite coatings with a nickel boron matrix and molybdenum sulfide as the dispersion phase, produced by the chemical reduction method on a carbon steel substrate are presented.

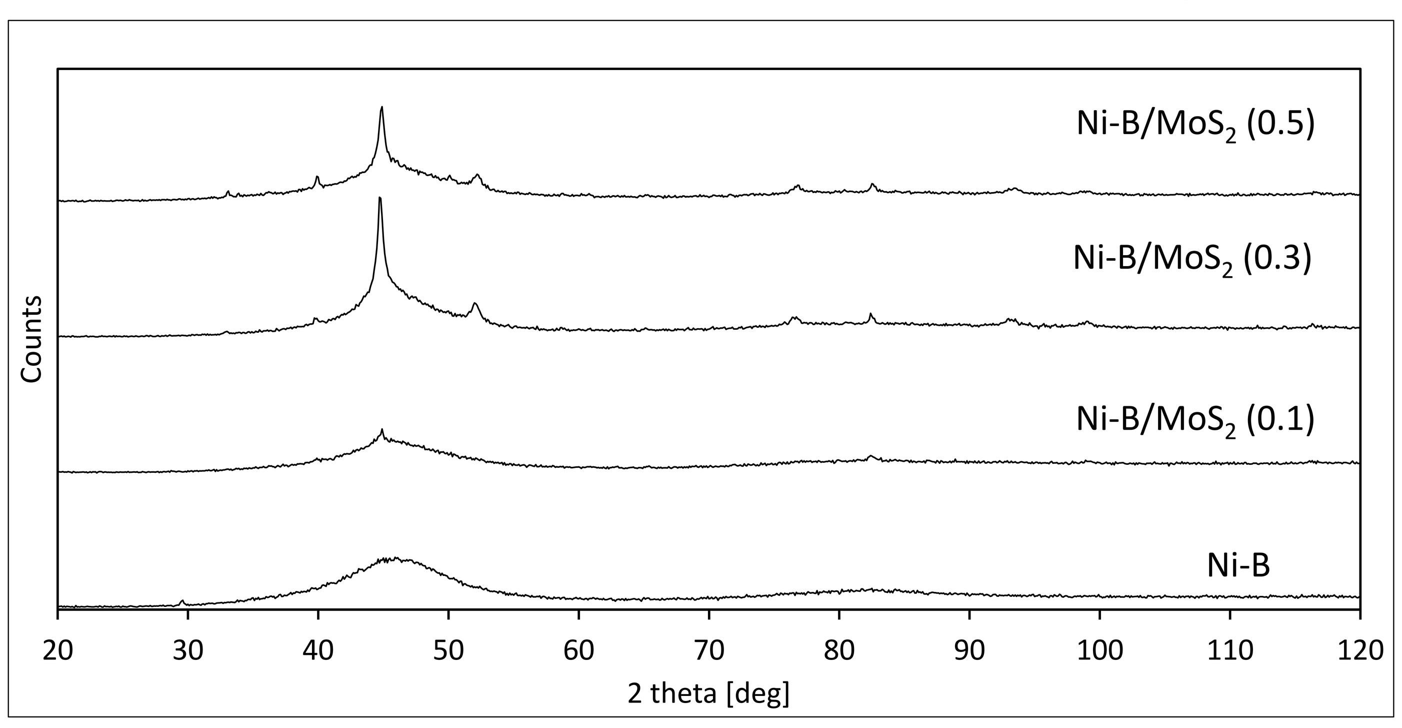

Fig. 1 XRD diffractograms of Ni-B and Ni-B/MoS_2 coatings

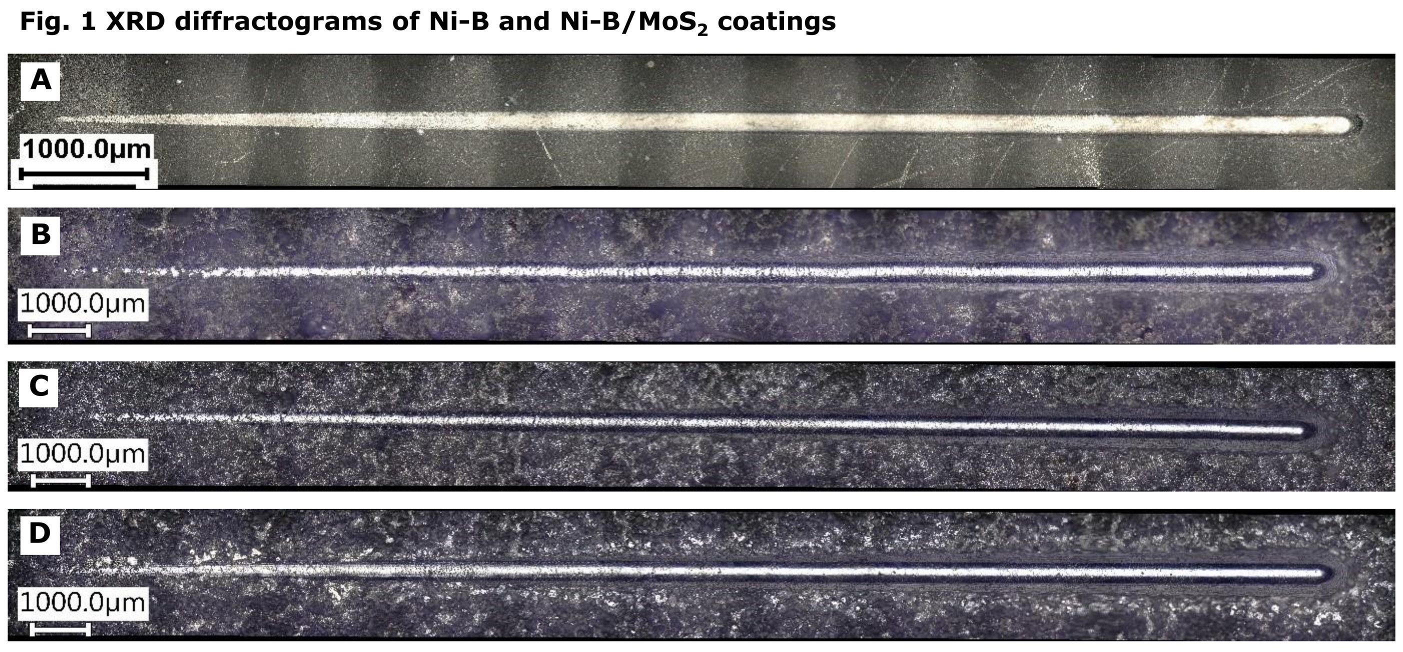

Fig. 2 Scratch test images of Ni-B and Ni-B/MoS_2 coating were A –Ni-B, B – Ni-B/MoS_2 (0.1), C – Ni-B/MoS_2 (0.3), D – Ni-B/MoS_2 (0.5)

Coating	Microhardness		Elastic modulus E_{it} [GPa]	Thickness [µm]
	H_{IT} [MPa]	H_M [MPa]		
Ni-B	10487	7077	214.0	24.70
Ni-B/MoS_2 (0.1)	7006	5025	173.0	15.70
Ni-B/MoS_2 (0.3)	4139	2842	87.2	13.70
Ni-B/MoS_2 (0.5)	4054	2892	84.5	13.10

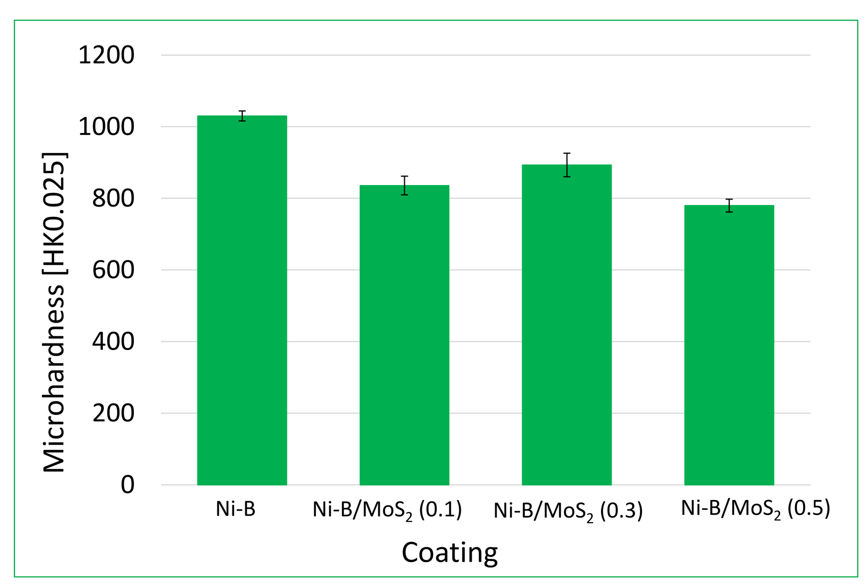

Fig. 3 Knoop microhardness values of Ni-B and Ni-B/MoS_2 coatings

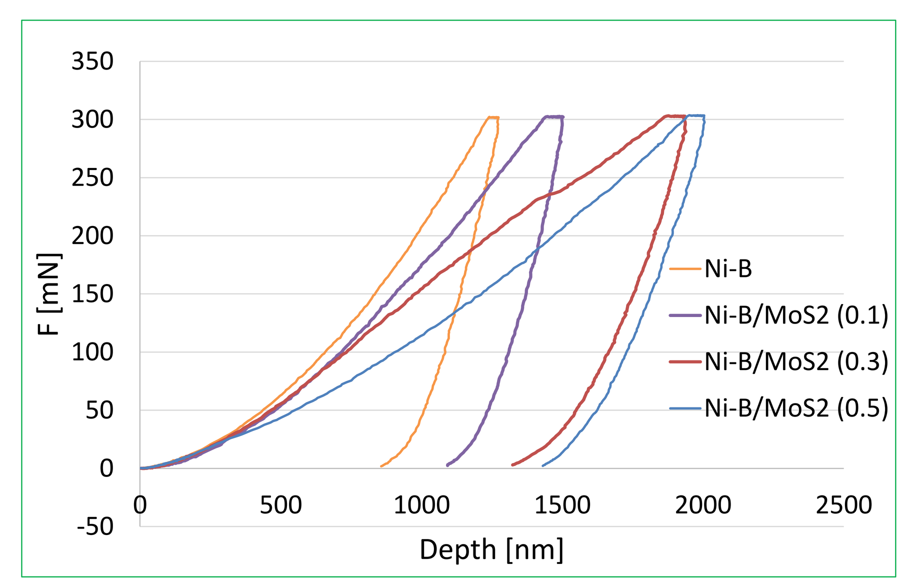

Fig. 4 Load dependence on the penetration depth of the indenter into the test material of Ni-B and Ni-B/MoS_2 coatings

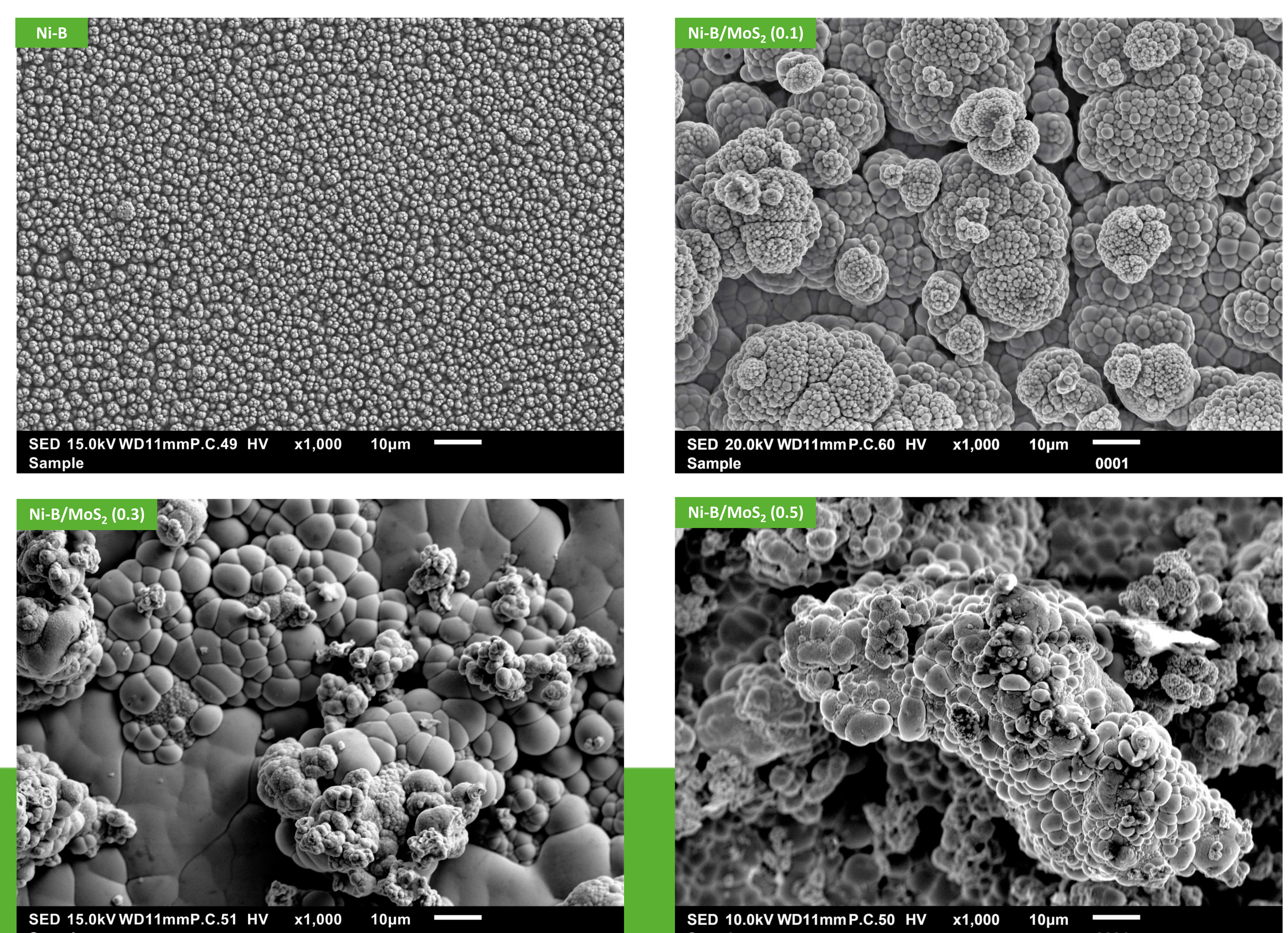

Fig. 5 SEM images of Ni-B and Ni-B/MoS_2 coatings

CONCLUSION

The sedimentation technique allows to obtain composite coatings with an amorphous Ni-B matrix and embedded MoS_2 particles. With increasing concentration of the dispersion phase in the bath we observe the appearance of larger agglomerates, which causes an increase in the surface development degree of obtained coatings. As the amount of MoS_2 in the bath increases, the microhardness of the tested coatings decreases, as well as the thickness. The results of adhesion tests of Ni-B and Ni-B/MoS_2 coatings to the steel substrate showed no delamination of the coatings and no damage of adhesive nature. The damage that occurs shows a cohesive nature and is mainly the result of indenter displacement with increasing load.

Acknowledgements:

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