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Effect of boron dispersion phase content on the microstructure and corrosion resistance of the Ni-B/B composite coatings

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INTRODUCTION

The paper presents the results of studies of composite coatings with nickel-boron matrix and boron particles as a dispersion phase produced by the chemical reduction method on a steel substrate. Four variants of composite coatings differ in the content of the dispersion phase in bath were produced as well as a nickel-boron coating without dispersion phase.
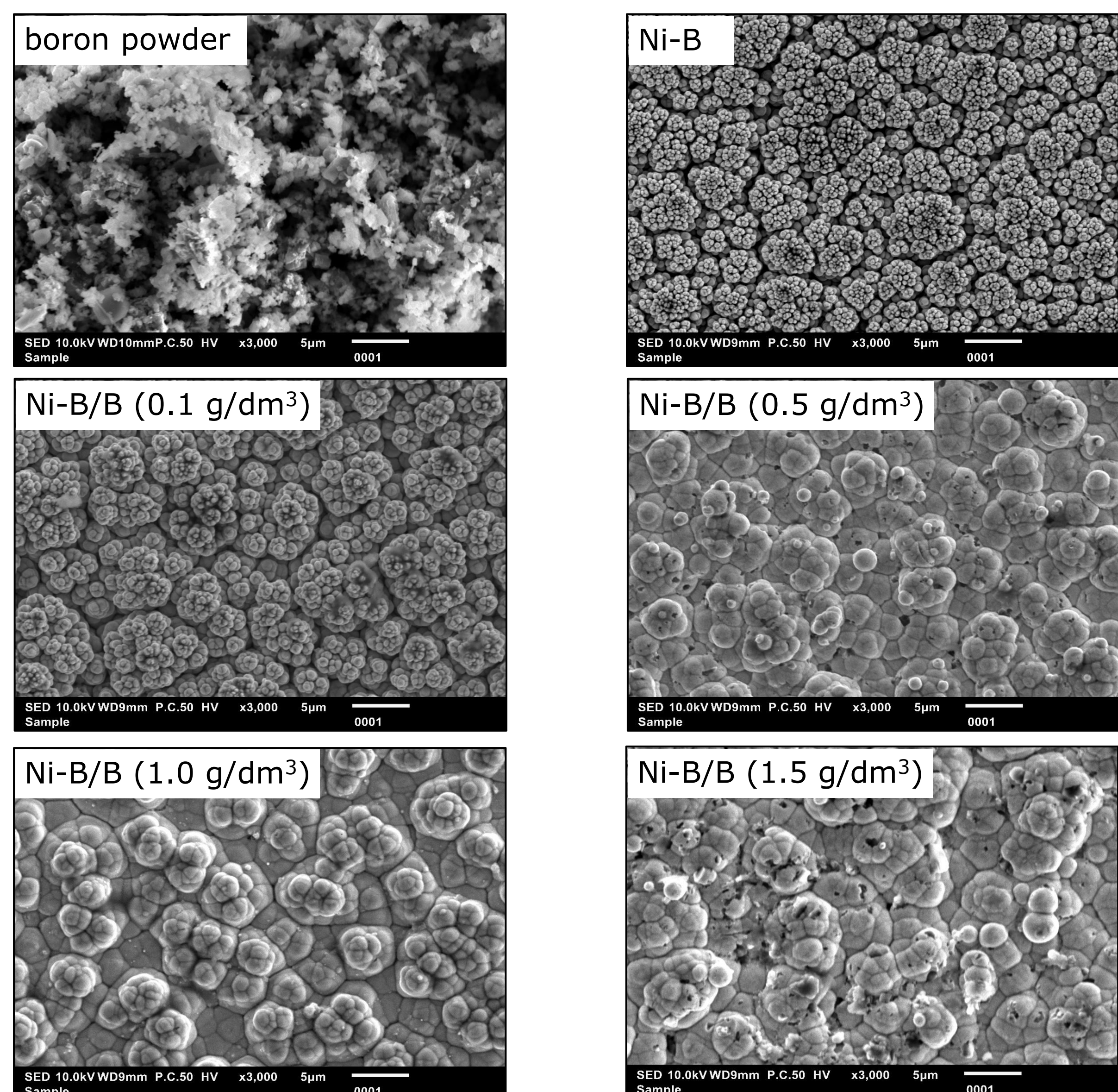
RESULTS

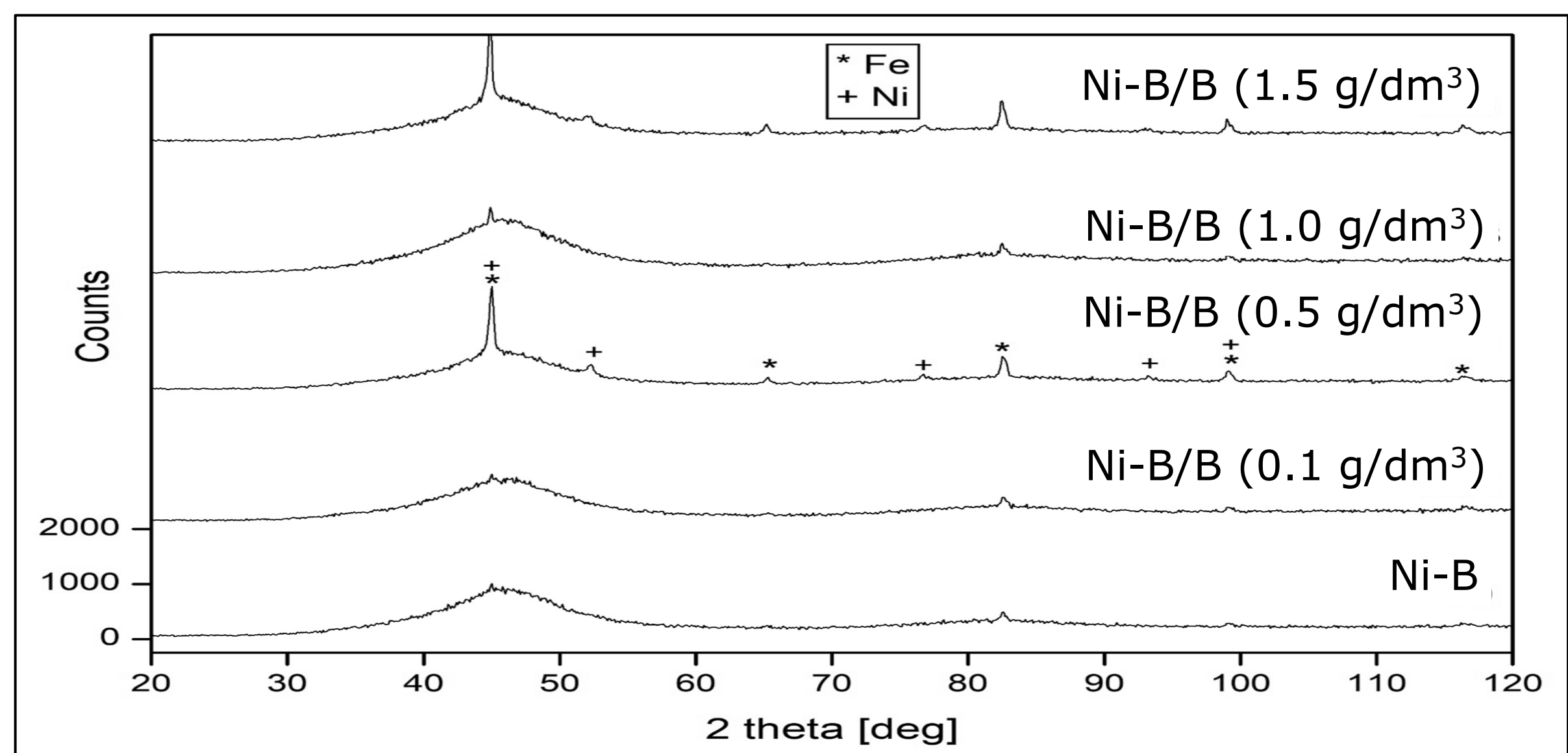Fig. 1. SEM images of boron powder and produced coatings

Fig. 2. X-Ray diffraction pattern of produced coatings

EXPERIMENTAL

The topography and surface morphology using the scanning electron microscopy (SEM) were presented. Characterization of the structure of the produced materials was performed using X-ray diffraction analysis and light microscopy. The corrosion tests of the Ni-B and Ni-B/B coatings were carried out with electrochemical potentiodynamic method.

Corrosion studies of the Ni-B and Ni-B/B coatings were carried out by electrochemical potentiodynamic polarization method in 0.15 M NaCl(aq) at room temperature in three electrode system – saturated calomel electrode (SCE 0.27 V vs. HE) as a reference electrode, an auxiliary electrode in the form of a platinum mesh and a working electrode, which was the tested sample. Scanning potential rate was 1 mV/s, tested surface of 1 cm².

Tab. 1. Microhardness of produced coatings

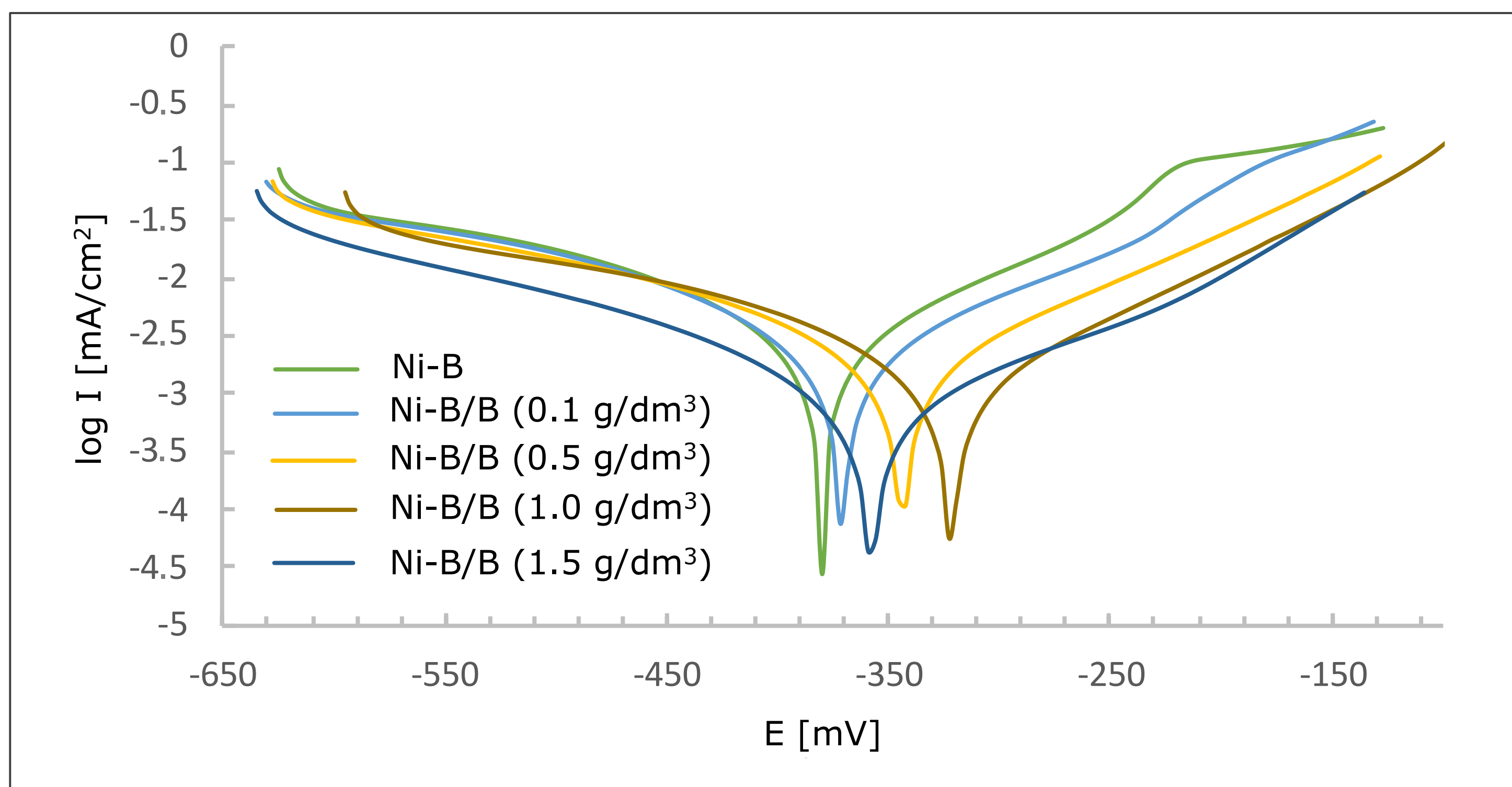| Microhardness HK0.025					
Coating	Ni-B	Ni-B/B (0.1 g/dm³)	Ni-B/B (0.5 g/dm³)	Ni-B/B (1.0 g/dm³)	Ni-B/B (1.5 g/dm³)
Mean value	718	752	873	924	883
Standard deviation	51	38	45	31	48

Fig. 3. Potentiodynamic polarization curves for produced coatings

Tab. 2. Electrochemical parameters of corrosion determined from polarization curves (Fig.3)

Coating	Ni-B	Ni-B/B (0.1 g/dm³)	Ni-B/B (0.5 g/dm³)	Ni-B/B (1.0 g/dm³)	Ni-B/B (1.5 g/dm³)
E_{cor} [mV]	-380	-370	-345	-321	-352
I_{cor} [µA/cm²]	2.2	1.85	1.42	0.85	0.58

CONCLUSIONS

The conducted research allowed to determine the effect of the dispersion phase content in the bath on the properties of the produced coatings. Incorporation of the boron particles into the Ni-B matrix affects the structure, morphology and properties of the composite coatings. Presence of boron particles in the coating increases the microhardness, with the highest value of 924 HK0.025 for Ni-B/B (1.0 g/dm³) coating. Increasing amount of B particles in the bath causes shifting of corrosion potentials into more positive values (from -380 mV for Ni-B coating to -321 mV for Ni-B/B (0.1 g/dm³) coating). Decreasing of corrosion current was observed: for Ni-B coating - 2,2 µA/cm² but for Ni-B/B (0.1 g/dm³) - 0,85 µA/cm². It can be concluded that the addition of boron particles increases the corrosion resistance of the composite coating compared to Ni-B alloy coating.

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