



**Figure 4.** Volt–ampere curves of an iron electrode in 0.3 M Na<sub>2</sub>SO<sub>4</sub> + 0.2 g/L Zr (IV) + 0.15 g/L W (VI) (a) and a change in the ionization current of the iron electrode (b) at different concentrations of Mo (VI)) (g/L): 1—0.1; 2—0.3; 3—0.5; 4—1; 5—1.5.

The concentration of molybdenum in a solution was changed from 0.01 to 0.3 g/L. According to Figure 4a, the addition of Mo (VI) ions led to the appearance of a small cathode wave at  $E = -1.08$  V and the displacement of iron electrode ionization potential to the anode region, indicating greater difficulty in the ionization process. According to Figure 4b, an increase in the concentration of molybdenum (VI) from 0.01 to 0.15 g/L in solution promoted a sharp reduction of the ionization current from 1.2 to 0.35 mA. A further increase in the tungsten (VI) concentration did not lead to a noticeable change in the ionization current of the iron electrode. Thus, the optimal electrolyte, in which the minimum ionization current of the iron electrode was observed, was the composition: 0.2 g/L Zr (IV) + 0.15 g/L W (VI) + 0.15 g/L Mo (VI) shown in Table 2.

**Table 2.** Influence of the electrolyte composition on the ionization current of the iron electrode at a potential of  $-0.3$  V.

Electrolyte Composition	Ionization Current, mA
0.3 M Na <sub>2</sub> SO <sub>4</sub> + (0.02–1.0 g/L) Zr (IV)	3.3–1.5
0.3 M Na <sub>2</sub> SO <sub>4</sub> + 0.2 g/L Zr (IV) + (0.01–0.2 g/L) Mo (VI)	0.75–0.25
0.3 M Na <sub>2</sub> SO <sub>4</sub> + 0.2 g/L Zr (IV) + 0.15 g/L W (VI)	0.9
0.3 M Na <sub>2</sub> SO <sub>4</sub> + 0.2 g/L Zr (IV) + 0.075 g/L W (VI) + (0.01–0.3 g/L) Mo (VI)	1.3–0.4
0.3 M Na <sub>2</sub> SO <sub>4</sub> + 0.2 g/L Zr (IV) + 0.15 g/L W (VI) + (0.01–0.3 g/L) Mo (VI)	1.2–0.35

According to Table 2, the smallest ionization current, and therefore the greatest corrosion resistance of the iron electrode, was observed in the electrolytes:

1. 0.3 M Na<sub>2</sub>SO<sub>4</sub> + 0.2 g/L Zr (IV) + (0.01–0.2 g/L) Mo (VI)
2. 0.3 M Na<sub>2</sub>SO<sub>4</sub> + 0.2 g/L Zr (IV) + 0.15 g/L W (VI) + (0.01–0.3 g/L) Mo (VI)

The results of the electrochemical study, given in Table 1, were used to select solutions for the deposition of oxide-zirconium coatings on the surface of steel samples with the highest corrosion resistance. Since coatings deposited from solutions containing Zr (IV) and W (VI) showed the highest corrosion resistance on steel samples with Mo (VI) ions, additional studies were carried out to determine the optimal conditions for the deposition of oxide-zirconium coatings from these solutions.

Figure 5 shows the change in the surface structure of steel samples with deposited oxide-zirconium coatings from a solution of 0.2 g/L Zr (IV) + 0.15 g/L W (VI) with different concentrations of Mo (VI). The deposition time was 10 min, the deposition temperature was 45 °C, the subsequent drying time was 10 min., and the drying temperature was  $-130$  °C.