PROPERTIES AND STRUCTURE OF NANOCRYSTALLINE IRON AND COBALT ALLOYS WITH TUNGSTEN DEPOSITED FROM GLUCONATE SOLUTION

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Recently Co-W covers which possess the high wear- and corrosion resistance, comparable to properties of chromium deposited from gluconate electrolytes are of great interest [1]. Such electrolyte is ecologically safety in comparison with chromium electrolyte. However conditions of Co-W alloys deposition from such electrolytes, as well as their properties are poorly understood. The influence of deposition conditions on structure of such alloys, their surface quality and mechanical characteristics were studied at wide range of deposition parameters variation

Electrolyte composition, M: $CoSO_4{\cdot}7H_2O$ – 0.053, sodium gluconate - 0.5, H_3BO_3 – 0.65, $Na_2WO_4{\cdot}2H_2O$ – 0.05, NaCl – 0.5. electrolyte pH – 5 - 8. Temperature 80°C. Current efficiency, chemical composition of coating, a modification roughness and microhardness of alloys were determined in different conditions of electrolysis. Morphology and a composition studied by means of scanning electron microscope TESCAN VEGA and system of element analysis INGA Energy EDX. Deposit structure were determined by means of diffractometer DRON 3.

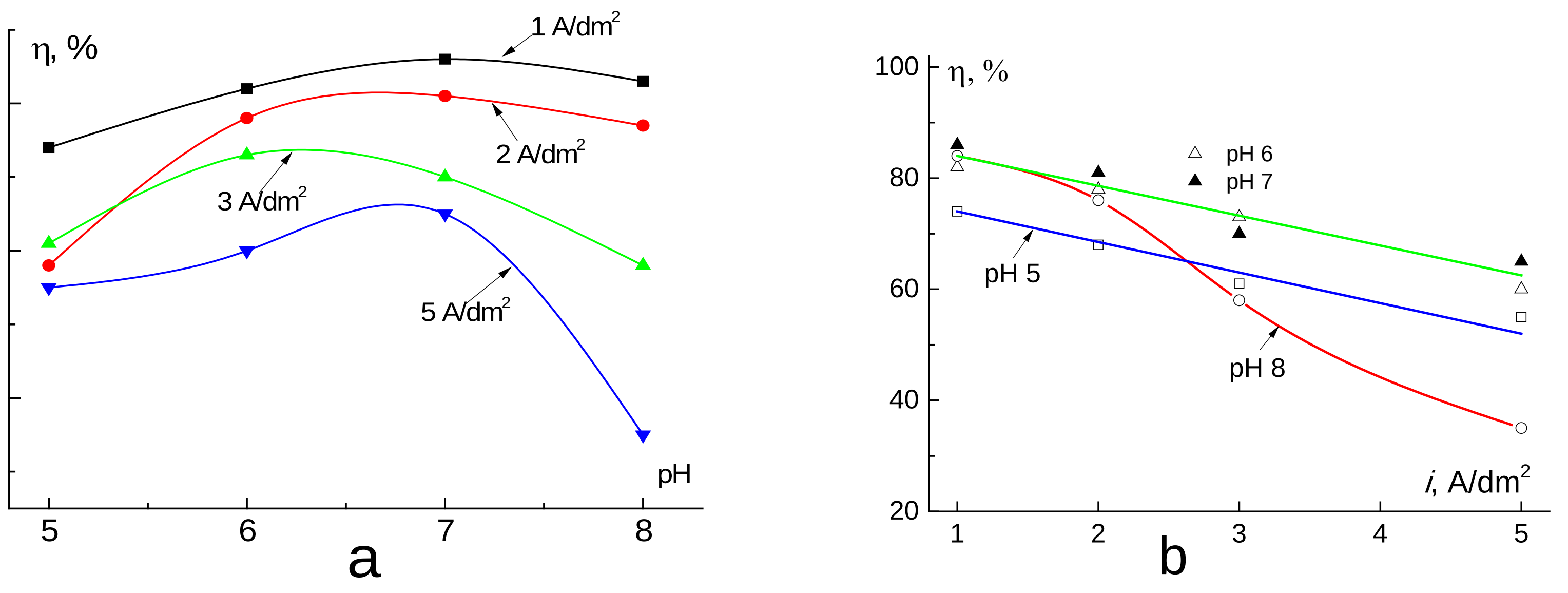

Fig. 1. Current efficiency versus pH (a) and current density (b)

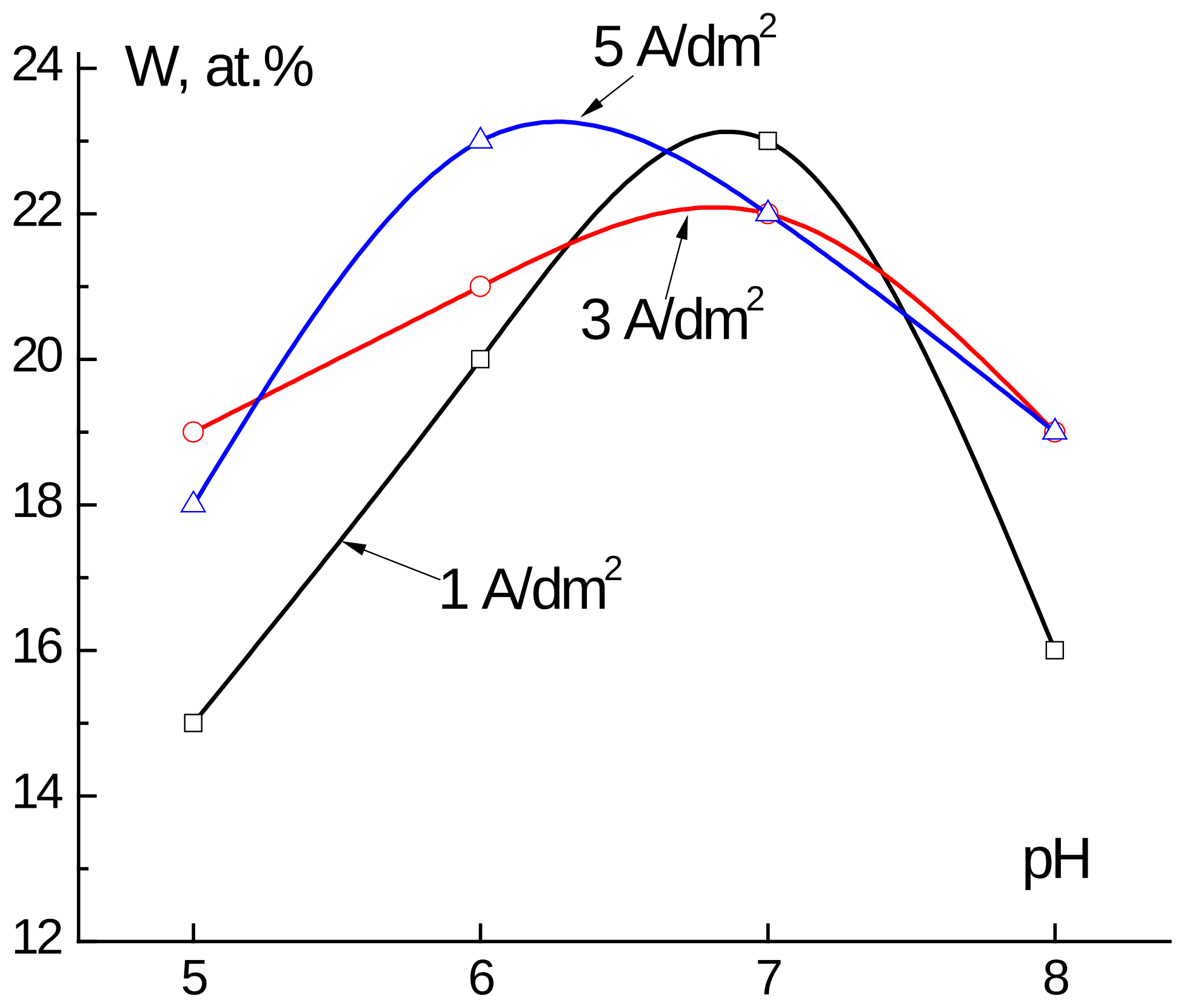

Fig. 2. W content of alloy - pH of electrolyte

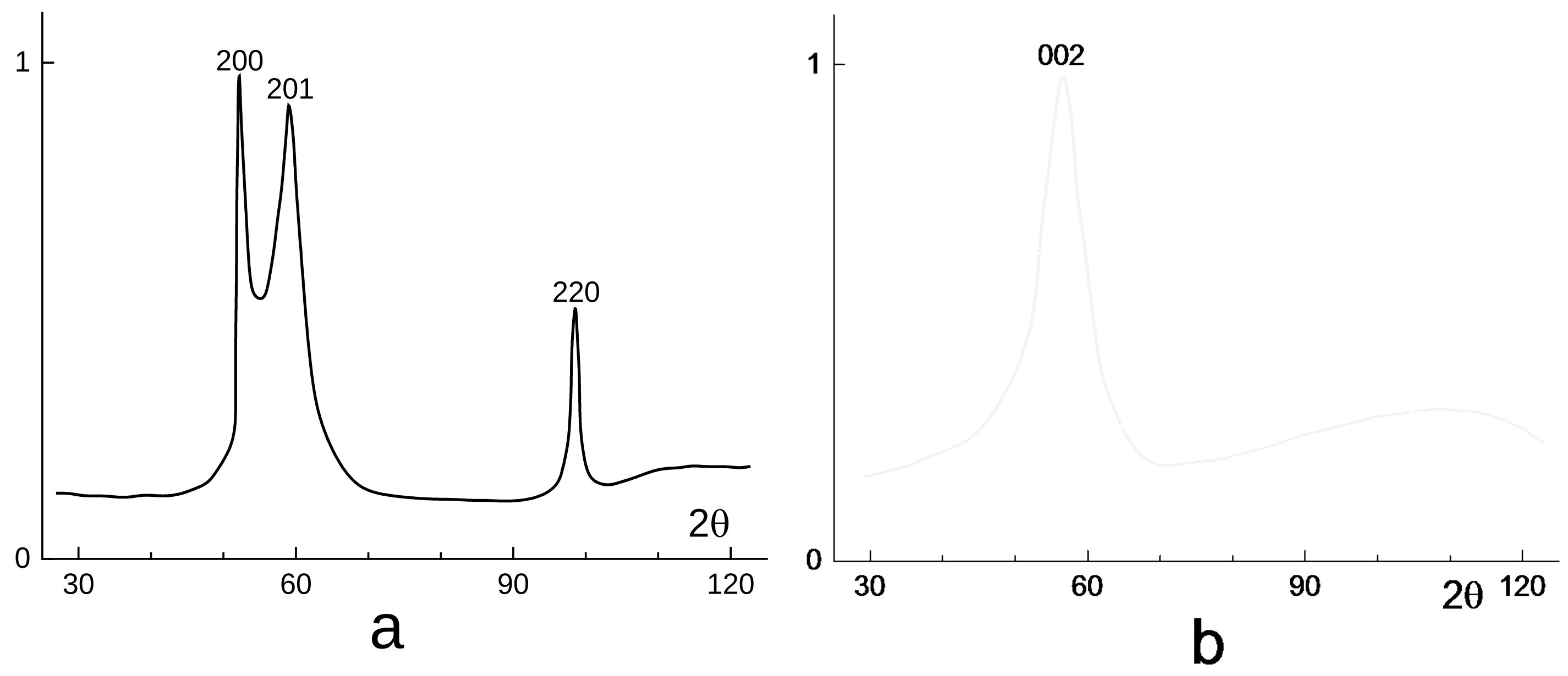

Fig. 3. Co-W alloy difractogramms: a) pH 8, i = 5 A/dm^2; b) pH 6 и I = 3 A/dm^2

Current efficiency η and tungsten content in the covers received from said electrolyte depend on solution pH and current density. Current efficiency is 80 – 85 % and tungsten content is 23 %atomic at pH 6-7 and i = 1 - 2 A/dm^2. The polycrystalline structure is characteristic for the covers deposited at current density 1 A/дм^2 and at all pH in the range 5 – 7. At the same electrolyte pH, but with current densities 3-5 A/dm^2 nanocristaline covers with the size of microcrystal - 2 nanometers are formed. Microhardness of the deposited alloys correlates with tungsten content, however in connection with deposit structural change at pH = 6.5, microhardness increased, attaining meaning Hv> 900 kg/mm^2.

The roughness slightly exceeded initial value practically at all deposition modes unlike the covers deposited from citrate electrolytes. Friction factor *k* of Co-W alloys lay within the limits 0,114-0,132 for all pH band (5–7), that does not exceed the friction factor of chromium (~0,134) tested in simular friction conditions. *k* growth is only at pH 8 when in an electrolyte there are modifications in the complexing of main electrolyte components.

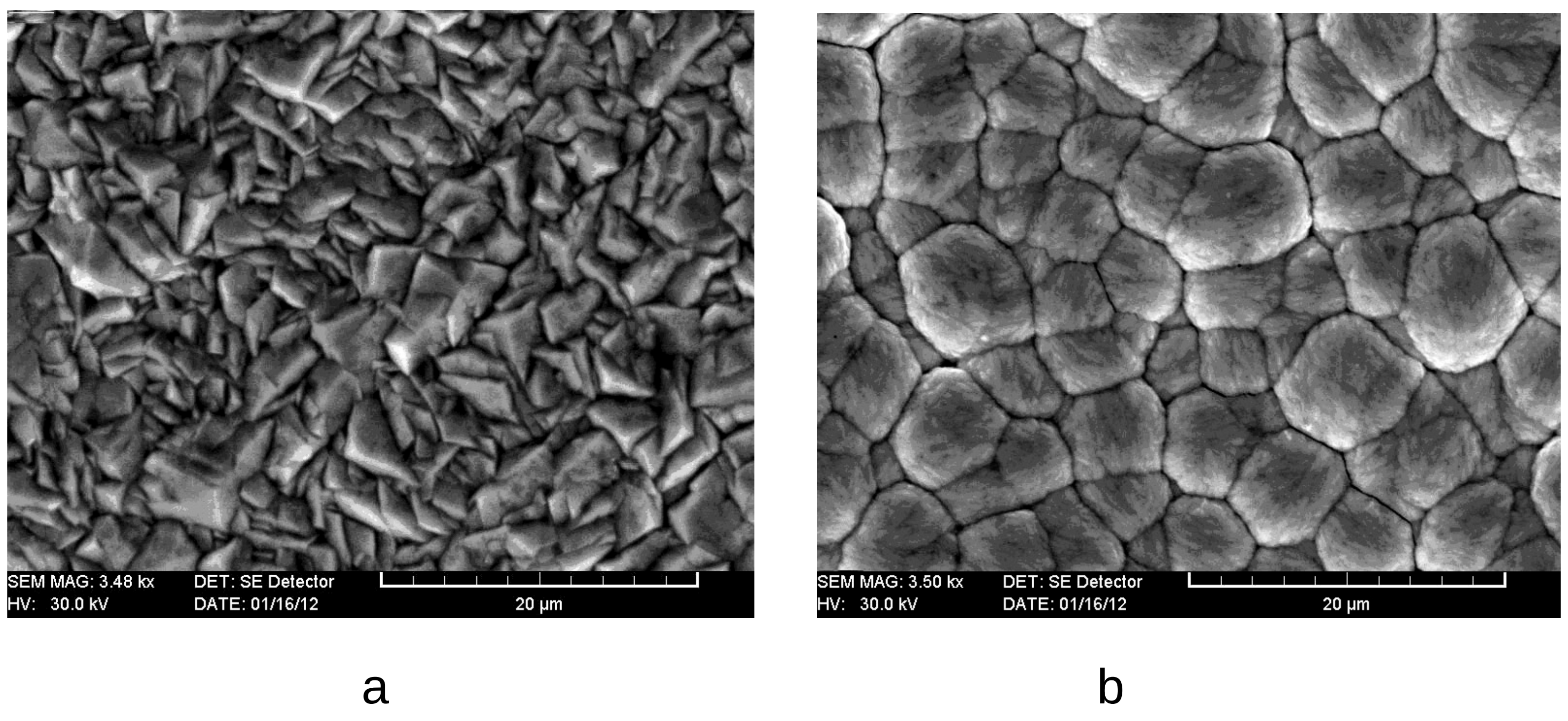

Fig.4. Morphology of Co-W alloys at: a) pH 6 and i = 1 A/dm^2;
b) pH 8 and i = 5 A/dm^2

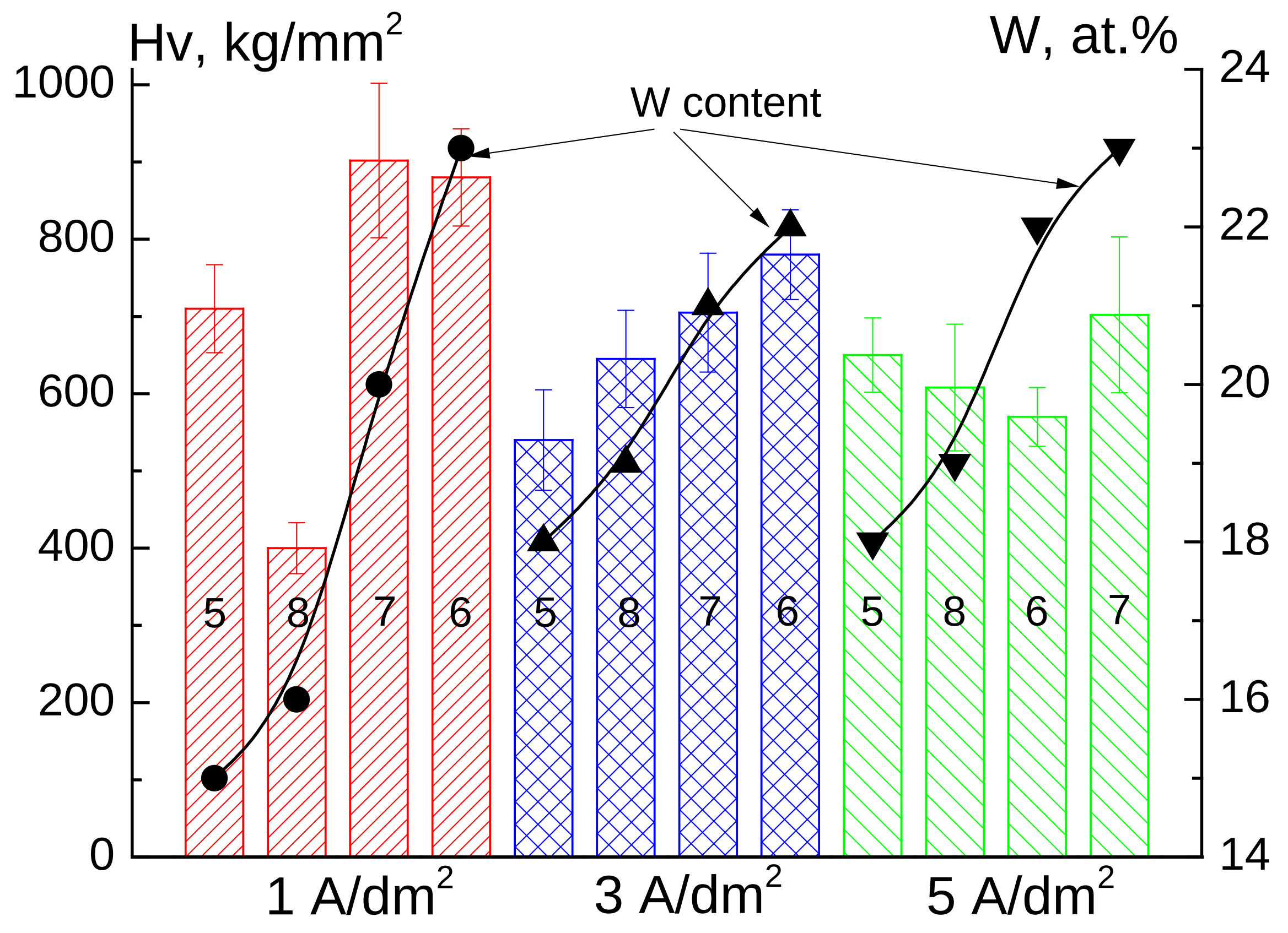

Fig. 5. Microhardness – W content relationship

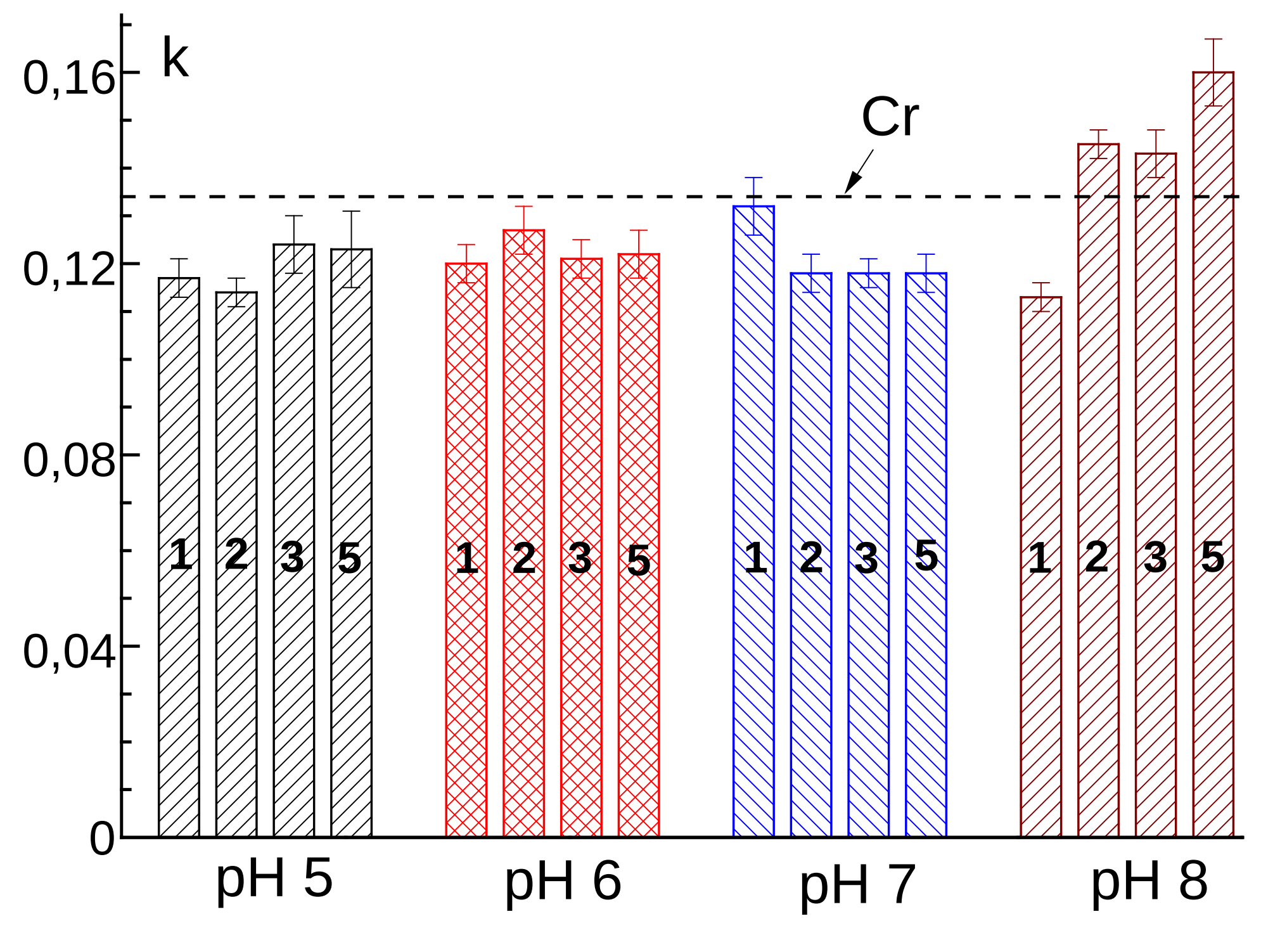

Fig.6. friction coefficient value for alloys deposited under different conditions.

Maximum deposition rates, tungsten content in covers, their microhardness and low friction factor are attained over the pH range 6 - 7. Presence of correlation between pH of gluconate electrolyte used for nanocrystaline Co-W alloys deposition, and deposition rate, coating content, their structure, microhardness and tribological properties may be explained as the result of formation of high-molecular complexes in electrolyte solution under corresponding conditions that is confirmed by means of gel filtration chromatography

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