

УДК 621.311.61

**COBALT-VANADIUM COATING
ELECTRODEPOSITION VIA PULSE MODE****Sakhnenko Mykola,**

Doctor of Technical Sciences, Professor, Professor;

Zhelavska Yulia,

Candidate of Technical Sciences (PhD.), Docent;

Zyubanova Svitlana,

Scientific researcher;

Dzheniuk Anatolii,

Docent, Docent;

Horokhivska Natalia,

PhD student;

Proskurina Valeriia,

Candidate of Technical Sciences (PhD.), Docent

National Technical University «Kharkiv Polytechnic Institute»

juliazhelavska@gmail.com

The development of functional materials with predictable properties is one of the priority directions in modern research. Obtaining new energy-saving materials for reducing the cost of hydrogen production in an electrochemical way is relevant for the hydrogen energy industry. Such electrode materials should have catalytic activity for the hydrogen evolution reaction. Catalytic properties can be predicted for coating alloys of the iron subgroup metals with vanadium, molybdenum, and tungsten [1]. The aforementioned metals can be co-deposited from aqueous solutions with iron subgroup metal catalysts through the formation of cluster intermetallic compounds with Me-V, Mo, W bond adsorbed on the cathode surface [2, 3].

The induced co-deposition of cobalt with vanadium from the complex citrate electrolyte via stationary and pulse electrolysis modes was investigated in the current work. As a result of the research, it was found that the uniform microcrystalline light-gray high-quality cobalt-vanadium alloy coating is possible to be deposited from a citrate electrolyte with content of 0,1 mol/dm³ vanadium (in terms of metal) as a citrate complex. The process was carried out at a current density of 1–15 A/dm² by stationary electrolysis mode and 2–10 A/dm² by pulse electrolysis mode, with a different ratio of pulse time to pause time, at a temperature range of 35–40 °C and pH = 3,0–3,5.

According to the results of the X-ray fluorescence (XRF) spectrometry, the maximum content of vanadium in the coating obtained via the programmable electrolysis mode is 1,20–1,45 %, which is tens of times more than in the coating

deposited by the stationary electrolysis mode (vanadium content 0,007–0,017 %) under similar conditions [4]. The obtained result may be a confirmation of the hypothesis of vanadium additional reduction from oxo-anions by adsorbed hydrogen atoms that formed on the cathode surface during the pause period. According to the results of the analysis of 2D graphs (Fig. 1, *a*, *b*), the optimal parameters of the process for obtaining a cobalt-vanadium coating with the vanadium maximum content in the alloy and the coating current yield have been established.

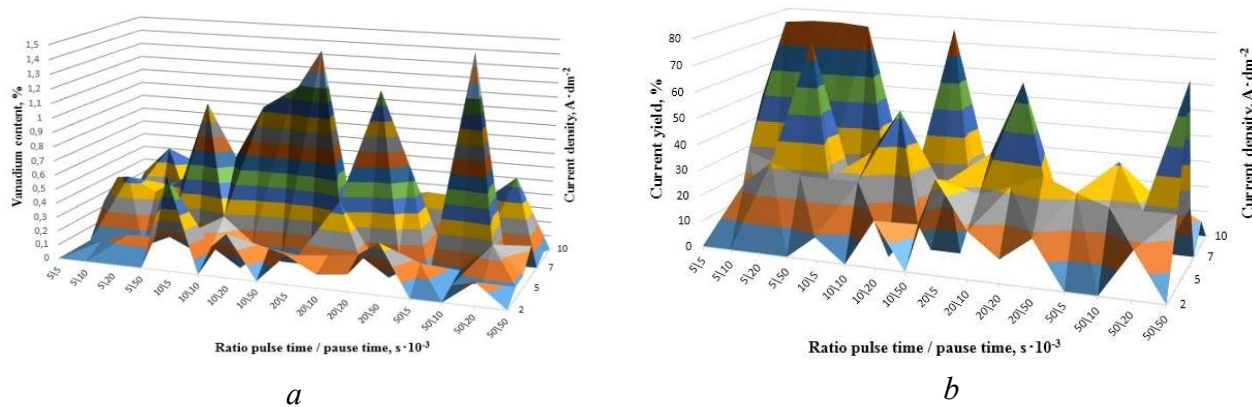


Fig.1 – Dependence of the vanadium content in the alloys (*a*) and coating current yield (*b*) on the current density and the ratio pulse time/pause time.

The maximum vanadium content in the alloy 1,45–1,5 % and the current yield of 80 % can be obtained at a current density of 5–7 A/dm² and a pulse and pause duration of $1 \cdot 10^{-2}$ – $5 \cdot 10^{-2}$ s.

References

1. Вєдь М.В., Сахненко М.Д. Каталітичні та захисні покриття сплавами і складними оксидами: електрохімічний синтез, прогнозування властивостей. Харків. 2010. 272 с.
2. Gamburg Yu.D, Zangari G. Theory and practice of metal electrodeposition. New York. 2011. 378 p.
3. Bairachniy B., Zhelavska Yu., Smirnova O., Pilipenko A., Finohenov O. Study of electrocatalytic activity of the vanadium-containing materials for the hydrogen evolution reaction. Materials Today: Proceedings. 2022. Vol. 50. P. 448–451. <https://doi.org/10.1016/j.matpr.2021.11.289>
4. Сахненко М.Д., Желавська Ю.А., Зюбанова С.І., Проскуріна В.О. Електрокаталітичні покриття кобальт-ванадій для реакції виділення водню. Вісник НТУ «ХП». 2021. № 49. С. 5–9. <https://doi.org/10.20998/2079-0821.2021.02.09>