Effect of codeposition of P on characterization and microhardness of electrodeposited Co–W coatings obtained from gluconate bath

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Electrodeposited Co–W alloy coatings are considered as one of the potential replacements for conventional hard chromium. However, it has been observed that addition of small amount of P in Co–W matrix greatly influences its properties. Therefore, it is envisaged that with appropriate composition, Co–W–P films may exhibit superior and unique properties which can be utilized in sophisticated electronic and automobile industries and space technology. In this work, Co–W–P coatings with different phosphorous concentrations have been prepared by direct current (DC) and pulse current (PC) electrodeposition methods using gluconate bath for the first time. The coatings were characterized by XRD, FESEM, AFM, DSC and XPS techniques. The current efficiency reduction decreases with the addition of phosphorous to the deposit. EDX analysis confirms the presence of cobalt, tungsten and phosphorous in the deposit and amount of P is observed to be more in PC coatings compared to DC coatings. XRD studies demonstrate that the coatings are nanocrystalline which on heat treatment show the formation of Co_3W phase. Phase transformation behavior from DSC studies exhibits the reduction in thermal stability with the addition of phosphorous. FESEM reveals the presence of spherical nodular morphology of the coatings, whereas increase in roughness with time and increase in P content is seen in AFM roughness measurement. It has also been observed that the PC coatings are smoother and have less number of nodules compared to that of DC coatings. Co is in both +2 and metallic states in all coatings, whereas W^0 and W^{6+} species are observed in all coatings. On the other hand, P is in $P^{\delta-}$ and P^{5+} states in these coatings. PC coatings show higher microhardness and it increases with heat treatment.

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