Nanocomposites and nanomaterials

Nanostructured cobalt and iron electrodeposited alloys

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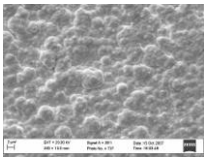
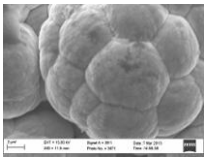
Metallic platinum and its alloys are known to be the most effective materials as catalysts, but their significantly high cost limits their usage. The focus of this study was to synthesize a replacement for the platinum based catalysts. Cobalt alloys were taken into consideration since they are highly effective in heterogeneous redox reactions. The goal was to establish a relationship between the chemical composition, surface morphology and catalytic properties of binary and ternary alloys, namely CoW, CoMoM (M – W, Zr), CoAg, CoAgM (M – Bi, Mo), FeCo and FeMo.

CoFe, FeMo, CoW and CoWM alloys were deposited from citrate electrolytes and CoAg, CoAgM – from citrate-pyrophosphate at room temperature using a IPC-Pro M potentiostat in the pulse and galvanostatic mode. Chemical composition of alloys was determined by X-ray fluorescence analysis using a portable spectrometer "SPRUT". Surface morphology was examined by scanning electron microscope ZEISS EVO 40XVP. The CoAg and CoW coatings surface roughness was investigated by scanning atomic force microscopy (AFM) NT-206.

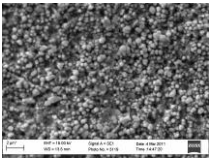
It was shown experimentally that the electrolytic alloys' composition strongly depends on the deposition mode and parameters. Such behavior opens the possibility to vary components' content in alloys in wide range. The cobalt and iron based alloys are characterized by globular developed surface morphology which depends on their composition (Fig.1) and consequently on the electrolysis regimes. At the same time silver based alloys have more fine-grained uniform surface which becomes more developed with addition of molybdenum or bismuth.



Co – 47.0; W – 53.0



Co – 70.4; Mo – 14.2; W – 15.4



Co – 87.7; Ag – 12.5

Fig.1 – Composition and morphology of electrolytic cobalt and iron based alloys

Atomic force microscopy of CoAg thin films allowed for concluding that the grain size was in the range of 80-100 nm. The CoW alloy surface consisted of bigger 1.5 mm in diameter structures and smaller 600 nm agglomerates.