Comparative study of pulsed laser induced synthesis and precipitation of nanostructured ternary Co-Fe-S based coat and nanoparticles

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Abstract:

Highly polymorphic iron and cobalt sulfides are attractive materials due to their unique electronic, optical, magnetic, mechanical and catalytic properties. Bimetallic Fe-Co sulfides are desirable materials due to their superior catalytic properties compared to their monometallic counterparts. A methods of pulsed laser deposition of equimolar FeS2+CoS2 target onto Ta substrate and the route of precipitation from $Na_2S.6H_2O$, $CoCl_2.6H_2O$, and $FeCl_2.4H_2O$ in a sodium metasilicate environment are presented. Thermodynamically non-equilibrium (laser ablation) and equilibrium (precipitation) processes provide different approaches to the preparation of bimetallic sulfides. The resulting materials were analysed by scanning and transmission electron microscopy, EDS, X-ray and electron diffraction and Raman spectroscopy. These complementary analyses revealed that the film on Ta consists of a bimetallic sulphide of cobaltpentlandite ($FeCo_8S_8$) and a smythite phase (Fe_3S_4). In contrast to the laser ablation process, the precipitation method leads to the formation of iron sulphide nanoparticles coated by a SiO_2 layer, whereas iron and cobalt sulphides are completely converted to oxides, e.g. wüestite FeO, upon removal of the stabilising SiO_2 coating by HF.