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## The tribological properties of electroless Ni–P/BN (h) composite coatings

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Electroless Ni–P coating has excellent mechanical properties which widely used in the petrochemical, computer, electronic machinery, automotive, printing, food and aerospace and other fields. The surface modification technology can strengthen material to achieve corrosion resistance, abrasion resistance, heat resistance, and prolong the service life of the material. It has found that the self-lubricating and wear resistance of electroless Ni–P coatings can be improved by the functional particles co-deposition. In recent years, countries all over the world have successively invested in research and development. In this study, hexagonal boron nitride (BN(h)) micro particles through electroless deposition process has successfully

co-deposited in Ni–P alloy coating. The particle contents present is 14.6 vol. % in electroless Ni–P/BN(h) composite coatings that will be analyzed include surface morphology, microstructure, hardness and tribological behavior. The micro morphology of coating was observed by Scanning electron microscopy(SEM), X-ray diffraction(XRD) to analyze crystalline phase. The tribological behavior of the coatings was investigated using a ball-on-disk wear tester that loaded at 6N. The results show that BN(h) particles co-deposited in Ni–P alloy coating can effectively reduce coefficient of friction to 0.18, and improve wear resistance 29 times for iron substrate.

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## Solventless synthesis of antimony sulfide, bismuth sulfide, and antimony-bismuth sulfide solid solutions using novel single source route

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Antimony(III) ethylxanthate  $[\text{Sb}(\text{S}_2\text{COEt})_3]$  and bismuth(III) ethylxanthate  $[\text{Bi}(\text{S}_2\text{COEt})_3]$  were used as a single source precursor for the preparation of  $\text{Sb}_2\text{S}_3$  and  $\text{Bi}_2\text{S}_3$ , respectively, by a melt method at different temperatures. In addition, The thermogravimetric analysis reveals that both precursors exhibit complete decomposition in similar temperature range. Therefore, the mixture of these precursors can be used to produce solid solutions of Bi-Sb-S between the two phases ( $\text{Bi}_2\text{S}_3$  and  $\text{Sb}_2\text{S}_3$ ). A series with varying stoichiometry was synthesized by using different molar ratios (i.e.  $\text{Sb}/\text{Sb}+\text{Bi} = 0.2, 0.4, 0.6$  and  $0.8$ ). The XRD peaks at all ratios correspond well to the orthorhombic crystals, where the peaks fall in between those of orthorhombic  $\text{Bi}_2\text{S}_3$  and orthorhombic  $\text{Sb}_2\text{S}_3$  for Bi-Sb-S system. The gradual splitting and shift in the peaks

position confirm the successful incorporation of antimony into bismuth sulfide. The inclusion of antimony was further confirmed by change in lattice parameters and is in good agreement with the literature values. A decrease of almost 3.5 % in volume was observed as moving from  $\text{Bi}_2\text{S}_3$  to  $\text{Sb}_2\text{S}_3$ . A change in all lattice parameters indicates that the substitution is random and not in any specific direction. The elemental compositions of all the samples were examined via EDX analysis and ICP- OES, which shows uniform distribution of elements in all samples. The morphology of all the samples was observed using SEM, revealing different morphologies as the composition changes from  $\text{Bi}_2\text{S}_3$  to  $\text{Sb}_2\text{S}_3$ .<sup>1-3</sup>

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