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Properties of Interfaced Materials and Films: Part II

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The ability to tailor the solid–solid interface for a desired functionality is of enormous interest to biologists/biochemists/biophysicists, chemists, physicists, materials scientists and engineers. By definition, it may be considered that the interface is one of the most common microstructures in the solid state.[1] While interfaces are buried between two solids and are therefore difficult to characterize, they play a critical role in a number of applications. The evolution of the interface, in solid–solid phase transformation, is often accompanied by change in density.[2] In recent years, studies relating to solid–solid interfaces have become multi-disciplinary and continue to attract the attention of researchers. These studies include multifunctional biomaterial interfaces based on adsorption of proteins,[3] ion-transport in fuel cells,[4] fluorinated interfaces in the development of safe batteries,[5] amorphous–crystalline solid–solid interfaces for improved radiative properties,[6] and solid–solid interfaces for a high-capacitance electric double layer for efficient electrochemical energy storage.[7]

The first part of the focused topic of *JOM*, Properties of Interfaced Materials and Films: Part I, was published in the October 2019 issue (vol. 71, no. 10). The papers in this focused topic of *JOM* represent the Properties of Interfaced Materials and Films: Part II.

The first article, "A Rapid Synthesis of Vertically Aligned Taper-Like K-Doped ZnO Nanostructures to Enhance Dye-Sensitized Solar Cell Efficiency" by Amir Sharifi Miavaghi et al., describes the growth of large-scale K-doped ZnO nanotapers grown on an indium tin oxide substrate using a facile electrochemical route. The structural and morphological analysis shows that the K-doped ZnO nanostructures have a nanotaper morphology and a strong preferential [0001] *c*-axis direction with a hexagonal polycrystalline structure. The results of the optical properties show that the incorporation of K+ ions as donors into the ZnO lattice leads to substantial modulation of the bandgap structure of ZnO nanotapers, which results in a red shift in the ultraviolet emission peaks.

Silicon light emitters are being eagerly sought in the photonics and communication industry and, upon achieving reasonable efficiencies, they may soon become available. The significant investments in Si-photonics by dominant semiconductor players implies that such devices will be in demand, particularly in applications, such as optical emitters for next-generation integrated optical circuits and interconnects, all-Si transceivers and cross-connects for integrated circuit chips, light-wave components, and high-power discrete and array emitters.

In "Engineered Stresses for Functional Si Light Emitter at Bandgap: An Overview," S. Abedrabbo et al. discuss stresses and strains, due to interfacing various materials that typically alter the properties of either or both interfaced surfaces. The authors focus on enhanced light emission properties at the bandgap of silicon that is interfaced with silica or layers of silica and silicon nitride. This discovery is corroborated by several examples of engineered stresses and strains at the bulk or the interface, such as implantation and/or diffusion of dopants in silicon, and rough silicon surfaces formed by wafer cutting or etching and patterning.

Yang et al. report their studies on "Titanium-Doped Copper-Diamond Composites Fabricated by Hot-Forging of Powder Mixtures or Cold-Pressed Powder Preforms". Cu-55vol%diamond-vol%Ti composites were fabricated by hot-forging of powder mixtures (referred to as M-Cu/Dia) and cold-pressed powder preforms (referred to as P-Cu/Dia). Dispersion of diamond particles in the size range of 70–80 μm at the volume fraction of 55% was attained in

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the P-Cu/Dia composites, while diamond agglomerations were observed in the M-Cu/Dia composites. TiC was observed at the copper/diamond interface in both composites, in which most diamond particle surfaces (>95%) were enveloped by TiC.

In "Comparative Investigation on the Tribological Performances of TiN, TiCN, and Ti-DLC Film-Coated Stainless Steel", Zhang et al. report their studies on TiN, TiCN, and Ti-diamond-like carbon (DLC) films, coated on 316L stainless steel surfaces by physical vapor deposition. All the films exhibited uniform and dense surfaces with good adhesion. The Ti-DLC films demonstrated the lowest surface roughness. TiC and free C were observed in both the TiCN and the Ti-DLC films.

Prakashiah et al. report their studies in "Improvement of Anticorrosion Properties of Epoxy Primer Coating on Aluminum Alloy 2024-T3 by Thiosemicarbazone Derivatives". The effect of adding thiosemicarbazone derivatives on the anticorrosion properties of epoxy primer coatings on the aluminum alloy 2024-T3 was investigated. 2,4-DHC- and 3,4-DHC-doped primer coatings exhibit good barrier properties, while the 2,3,4-THC-doped primer coating exhibits good barrier properties along with active corrosion protection.

"A Novel Method for Assessing Material Heterogeneity-Induced Interfacial Stress Singularities of Dissimilar Joints Under Normal Loading" by Wen et al. is a study on the influence of interfacial stress singularities on the strength, stiffness, and fracture behavior of dissimilar joints. Commonly used stress singularity assessment methods are based on the two-dimensional theory of elasticity, which is complicated for design purposes. Three-dimensional (3-D) finite element analysis results show that the traditional method does not fully reflect the influence of material heterogeneity, especially Poisson's ratio, on interfacial stress singularities. This paper presents an interfacial stress intensity factor based on the 3-D theory of elasticity, which characterizes the increasing rate of interfacial stress as the external force in dissimilar joint increases.

"Integration of Anhydrous Sodium Acetate (ASAc) into Concrete Pavement for Protection against Harmful Impact of Deicing Salt" by Al-Kheetan et al. deals with the application of de-icing salt which is essential to maintain serviceability of concrete pavement in the winter months, although the penetration of salt through micro-cracks and pores can be harmful to the underlying reinforcement. This research aims to develop shielded concrete by integrating a novel anhydrous sodium acetate compound in fresh concrete. The research presents results from a comprehensive laboratory investigation to analyze the mechanical, physical and morphological properties of shielded concrete.

The following papers, published under the topic of Properties of Interfaced Materials and Films: Part II, provide excellent details and research on the subject. In order to download any of the papers, follow the URL, http://link.springer.com/journal/11837/71/12/page/1, to the table of contents page for the December 2019 issue (vol. 71, no. 12).

- "A Rapid Synthesis of Vertically Aligned Taper-Like K-doped ZnO Nanostructures to Enhance Dye-Sensitized Solar Cell Efficiency" by Amir Sharifi Miavaghi, Miragha Musavi, and Seyed Alireza Pezeshkzadeh.
- "Engineered Stresses for Functional Si Light Emitter at Bandgap-An overview" by S. Abedrabbo, N.M. Ravindra, and A.T. Fiory.
- "Titanium-Doped Copper-Diamond Composites Fabricated by Hot-Forging of Powder Mixtures or Cold-Pressed Powder Preforms" by F. Yang, Y. Su, S.Q. Jia, Q.Y. Zhao, L. Bolzoni, T. Li, and M. Qian.
- "Comparative Investigation on the Tribological Performances of TiN, TiCN, and Ti-DLC Film-Coated Stainless Steel" by Jie Zhang, Jia Lou, Hao He, and Youneng Xie.
- "Improvement of Anticorrosion Properties of Epoxy Primer Coating on Aluminum Alloy 2024-T3 by Thiosemicarbazone Derivatives" by B.G. Prakashiah, A Nityananda Shetty, and B.E. Amitha Rani.
- "A Novel Method for Assessing Material Heterogeneity-Induced Interfacial Stress Singularities of Dissimilar Joints Under Normal Loading" by Xue Wen, Ping Wang, Zhibo Dong, and Hongyuan Fang.
- "Integration of Anhydrous Sodium Acetate (ASAc) into Concrete Pavement for Protection against Harmful Impact of Deicing Salt", by Mazen J. Al-Kheetan and Mujib M. Rahman.

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