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# Editorial

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It has been fifty years since 'the golden rule for the electronics industry' was postulated (Intel Corporation, 2016).[1] Gordon Moore's prediction,[2] cited 10 009 times, states that computing would increase in power and decrease in cost, at an exponential pace,[3] and will continue to have an enormous impact on the world economy. While Moore's prediction of the doubling of the number of transistors per square inch on an integrated circuit every two years was realized in 1975,[4] its pace has decelerated in recent years.[5] With 450 mm silicon wafers entering production in 2018[6,7] (Taiwan Semiconductor Manufacturing Company Ltd, Intel and Samsung) and the semiconductor industry's first 14 nm process technology now in volume manufacturing (Intel),[8] it is anticipated that thermal management of integrated circuits will be the most critical factor that will limit the number of transistors per unit area in an integrated circuit.

This year marks the 25th anniversary of arXiv (see https://arxiv.org/). Hosted and managed by Cornell University, NY, USA, arXiv provides an open-access repository of scientific research to authors and researchers worldwide. In January 2015, arXiv passed the 1 million paper milestone. In 2012, the Simons Foundation (see https://www.simonsfoundation.org/) facilitated the development of a sustainability model to strengthen arXiv's infrastructure. Today, arXiv is a collaboratively governed, community-supported resource. It has nearly 200 institutional members in 24 countries that support arXiv financially. arXiv has become an excellent model, across the globe, for other organizations in terms of its fundamental commitment to providing free access to its vast intellectual vault, infrastructure and philosophy that permits sharing of knowledge. arXiv is an outstanding example of a sustainable repository. At the time of writing of this Editorial, arXiv had open access to 1 139 732 e-prints in physics, mathematics, computer science, quantitative biology, quantitative finance and statistics.

The American Chemical Society (ACS) (see http://www.acs.org/content/acs/en.html) is celebrating its 140th anniversary. With nearly 157 000 members from over 140 countries, ACS has become the largest scientific society in the world. Since 1968, Project SEED, established by ACS, helps economically disadvantaged high school students to enhance their educational skills. Over the last 15 years, I have had the pleasure of hosting students from various high schools in my research group. Perhaps one can argue that the gift of education and knowledge helps to build a better society with a well-equipped future.

With a membership of more than 421 355 from over 160 countries, The Institute of Electrical and Electronics Engineers (see https://www.ieee.org/about/today/at_a_glance.html) is the world's largest technical professional organization. This year marks the 120th anniversary of Guglielmo Marconi's wireless telegraphy experiments.

Professor Walter Kohn (see http://web.physics.ucsb.edu/~kohn/), the winner of the 1998 Nobel Prize (see http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1998/) in Chemistry for his development and contributions to density functional theory (DFT) passed away on 19 April 2016. Today, DFT has become one of the standard tools for understanding the electronic structure of materials.[9]

Weilin Shi, Weixia Gu and Xiying Ma of the Suzhou University of Science and Technology, Suzhou, Jiangsu, China present their studies on the 'Electronic structure of two dimensional germanene crystals'.[10] Two-dimensional germanene crystals, the counterpart of graphene with honeycomb structure, will be an alternative semiconductor material for the next-generation nanoelectronic applications. In this study, the authors have calculated the electronic structure, energy band gap and the electron density of germanene using the tight-binding approach, and analyzed the results of the calculations. By developing the model based on tight-binding theory and calculating the electronic structure of germanene, they obtained the three-dimensional energy band structure in the first Brillouin zone for germanene, which has an open energy gap up to 128 meV at the Dirac points $K$ and $K'$. This open gap shows that germanene is a non-metallic insulator. The first Brillouin zone is almost three times larger than that of graphene because germanene has a larger lattice constant (3·95 Å). The electron density quickly decreases with radial direction, while the density is larger in the center of the Brillouin zone in the angular direction.

The next paper in this issue focuses on 'Study of the surface plasmon properties in $MoS_2$-Ag film system'.[11] This paper is by Weilin Shi, Miaoyuan Shi and Xiying Ma of the Suzhou University of Science and Technology, Suzhou, Jiangsu, China. The authors present a study on the surface plasmon properties in a $MoS_2$-Ag system formed by $MoS_2$ and Ag plates with periodically arrayed small Ag slices on them. The propagation properties of an electromagnetic wave moving in the system are solved in the framework of finite-difference time-domain (FDTD) method. They found that the intensity of the electric vector $E$ in the system is closely related with the position and the width of the Ag slices. It enhanced almost two times when single or double rows of the small Ag slices are located in the system. The enlarged intensity indicates that the surface plasmons are excited in the system, resulting from the collective oscillation of electrons in Ag plate and slices under the stronger interaction between the electromagnetic wave and electrons. Moreover, the intensity increased about three times when the width of Ag slices was doubled. The enhanced vibrations, induced by the surface plasmons in the $MoS_2$-Ag system, have significant applications in high efficiency solar cells, detectors and other optoelectronic devices.

'Electron beam effects in Ge–Se thin films and resistance change memory devices' by Kasandra Wolf, Mahesh S. Ailavajhala, Dmitri A. Tenne, Hugh Barnaby, Michael N. Kozicki and Maria Mitkova is a collaborative effort between the Department of Electrical and Computer Engineering, Boise State University, Boise, ID, USA and the Department of Physics, Boise State University, Boise, ID, USA.[12] Chalcogenide glasses are the advanced materials of choice for the emerging nanoionic memory devices – conductive bridge random access memory (CBRAM). In order to understand the nature of the effects occurring in these devices, under the influence of electron-beam radiation, the interaction of blanked chalcogenide films and nanostructured films containing chalcogenide glass and silver (Ag) source were studied. Raman spectroscopy, energy-dispersive X-ray spectroscopy and X-ray diffraction are used for establishing the structural and compositional effects occurring under radiation. They have strong compositional dependence with the stoichiometric compositions being the most stable, showing less structural changes after radiation. These effects are associated with the availability of lone-pair electrons, their participation in the bonding configurations and the coupling of electron states in the bandgap. They are further enhanced in the bilayers by silver diffusion in the chalcogenide matrix as a result of the interaction with electrons. These effects are used to interpret the electrical performance of CBRAM devices after radiation. The devices are characterized by their resistance states, threshold voltage and endurance. Those based on selenium-rich and stoichiometric composition undergo continuous parameter changes with increase in radiation dose, while in the devices based on germanium-rich composition, a counter play of the structural changes and expulsion of silver occur.

The paper 'DFT study of methoxy adsorbed on Ni-doped Cu (100) surface' is by Zhengxin Yan, An Gong, Wei Liu, Shaorong Li, Shengyong Wang, Qian Liao and Qian Chen of the College of Science, Xi'an University of Science and Technology, Xi'an, China.[13] In this study, the properties of methoxy ($CH_3O$) adsorbed on nickel (Ni)-doped copper (Cu) (100) surfaces are investigated using the density functional theory–conjugated gradient analytic simulation approach. The adsorption characteristics of methoxy on copper (100) surface, with varying nickel-doping coverage, were analyzed. The results of the simulation demonstrate that the adsorption energy of methoxy increases with doping coverage and is sensitive to the adsorption sites. It is concluded that nickel-doping can improve the adsorption performance of methoxy on copper (100) surface, and the hollow site is a preferable site. From the analysis of projected density of states, Mulliken population and electron density, it shows the charges transferred from the metal to the methoxy as an oxygen atom strongly bonded with metal atoms. These charges mainly stem from copper atoms around the methoxy. The results of this work will guide the experiment of methanol and methoxy adsorption on metal surface and will help in developing sensors.

The next paper is on 'Effects of sintering temperature on mechanical properties of Ti/$Al_2O_3$ composites' by Guo-pu Shi, Zhi Wang, Chao Wu and Cheng-Guo Wang of the School of Material Science and Engineering, Shandong University, Jinan, China.[14] In this study, Ti/$Al_2O_3$ composites were fabricated by vacuum hot-pressing sintering technique at sintering temperature in the range of 1420–1480°C. The dependence of sintering temperature on the mechanical properties of the composites was discussed. The results showed that the mechanical properties, microstructure and phase constitution of the composites exhibited dependence on the sintering temperature. When the sintering temperature is 1450°C, the composites with 3 vol% $CeO_2$ showed the best mechanical property. The relative density, Vickers hardness, flexural strength and fracture toughness of the composites were 98·7%, 16·4 GPa, 487·2 MPa and 6·88 MPa•$m^{1/2}$, respectively. When the sintering temperature was 1480°C, the mechanical property of the composite decreased significantly; this was mainly attributed to the abnormal grain growth owing to the over-sintering phenomenon.

The paper 'Autocatalytic Ni-P and Ni-B deposition on SiC powders' is by Gökce Sezen, Ayfer Kilicarslan, Sibel Daglılar and Isıl Kerti of the Department of Metallurgical and Materials Engineering, Yildiz Technical University Davutpasa Campus, Esenler, Istanbul, Turkey.[15] Ceramic particles such as silicon carbide (SiC) have attracted significant attention because of their usability as reinforcement for composite materials. Autocatalytic (electroless) nickel deposition is an excellent process for the enhancement of surface properties of ceramic particles. In this study, deposition of nickel phosphorus (Ni-P) and nickel boron (Ni-B) layer on SiC particles via autocatalytic plating in hypophosphite and borohydride baths were investigated. SiC powders were sensitized and activated respectively in order to ensure catalytic properties. Electroless nickel coating was performed from two different nickel ion sources (nickel chloride and nickel sulphate) following the pre-treatments of particle surfaces. Coated powder morphologies were characterized by scanning electron microscopy. Energy dispersive spectroscopy was used to investigate the chemical analysis of the coatings. The results showed that a better uniformity and bonding were obtained for Ni-P coatings with the $Ni^{2+}$ source of $NiSO_4.6H_2O$ as compared to $NiCl_2.6H_2O$. For Ni-B coatings, the $Ni^{2+}$ source of $NiCl_2.6H_2O$ provided better quality and continuous coating layer on SiC surfaces.

Mazhar ul Haq and Zhao Gang of the Department of Mechanical and Electrical Engineering, Harbin Engineering University, Heilongjiang, People's Republic of China, report their studies on the 'Ionic polymer–metal composite applications'.[16] In this paper, the authors present a comprehensive review of ionic polymer–metal composites (IPMCs) covering their fundamentals, fabrication processes, characterization and applications. IPMCs are becoming increasingly popular among scholars, engineers and scientists due to their inherent properties of low activation voltage, large bending strain – that is, the transformation of electrical energy to mechanical energy – and properties that can be used for its application as a bidirectional material. Thus, they can be used as actuators and sensors. Among the diversity of electroactive polymers, recently developed IPMCs are good candidates for use in bio related applications because of their biocompatibility. The applications of IPMCs have been growing due to the progression in their manufacturing techniques, development of more accurate control models and recently demonstrated sophisticated IPMC actuator applications. This indicates that IPMC actuators hold potential for more sophisticated applications in control systems. Several recently reported IPMC fabrication processes, mechanical characteristics and performances, and a number of recent IPMC applications have been reported in this paper. Extensive references are provided for a more in-depth explanation of their related properties and applications.

Shihua Wei and Weimin Li of the Mechanical and Electronic Department, Taizhou Polytechnical Institute, Taizhou, China, report their studies on 'Processing of composite diamond coatings-based drawing die'.[17] In this paper, the drawing die of cemented carbide WC-Co (Wolfram carbide-cobalt) was taken as the substrate. It was preprocessed by metallographic sandpaper, acetone, deionized water, Murakami solution and aqua regia. Direct current magnetron sputtering was adopted to sputter Ta interlayer in the bore of the drawing die. By using electron-assisted chemical vapor deposition, micro-nano composite coating was deposited. The specimens were characterized by applying methods such as 3D-profilometry, Rockwell hardness tester, scanning electron microscopy and Raman spectroscopy. Results indicated that the drawing die showed very smooth coating surface and a compact, uniform structure; the grain size was <50 nm and surface roughness was <10 nm. It can be inferred from the indentation tests that there was smaller internal stress in the coating and satisfactory adhesion between the coating and the substrate. Thus, the drawing die can satisfy the working requirement of drawing wires.

The paper 'Agglomeration behavior of solid waste materials in steel plants'[18] presented by Prince Kumar Singh, Prvan Kumar Katiyar, Avala Lava Kumar, Dinesh Kumar Mishra and Ajit Behera is a collaborative effort between the Department of Materials Science and Engineering, Indian Institute of Technology, Kanpur, India, the Department of Metallurgical and Materials Engineering, Veer Surendra Sai University of Technology, Burla, India, and the Department of Metallurgical and Materials Engineering, National Institute of Technology, Rourkela, India. This paper discusses the behavior of solid wastes such as blast furnace flue dust and sludge in steel plants. These wastes consist of metal oxides and coke fines as valuable materials with some alkali oxides. Processing of wastes obtained from steel plants is challenging. In this study, pellets of these wastes were prepared with three types of binders such as molasses, dextrin and bentonite. These pellets were used for the preparation of iron ore sinter in a pot-type laboratory-grade sintering machine. The results reveal that the compressive strength and shatter strength are better in the case of bentonite binder. This binder provides high compressive strength as well as minimum shatter index value. Thereafter, the utilization of these carbon-containing pellets in sintering operation improves the productivity of sintering machine as well as decreasing coke consumption in the process.

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