*electronic materials*

*Editorial*

# Inorganic Semiconductors in Electronic Applications

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Inorganic semiconductors have a wide range of applications in various fields, including electronics, optoelectronics, photovoltaics, and even catalysis. Some of the key features of inorganic semiconductor applications are essential for the development of future technologies. Inorganic semiconductors such as silicon, germanium, and gallium arsenide are widely employed in electronic devices such as transistors, diodes, and integrated circuits. These materials have excellent electrical properties, making them ideal for application in electronic components. Inorganic semiconductors are also employed in optoelectronic devices such as light-emitting diodes (LEDs), laser diodes, and photodetectors due to their unique optical properties, which make them ideal for use in these applications. Inorganic semiconductors such as silicon and cadmium telluride are also applied in solar cells to convert sunlight into electricity. These materials have excellent photovoltaic properties, making them ideal for utilization in renewable energy applications. Overall, inorganic semiconductors play a critical role in modern technology and have a wide range of applications in various fields. The Special Issues "Feature Papers of Electronic Materials" and "Papers of Electronic Materials II" managed to collect outstanding publications on inorganic semiconductor materials and their application in advanced technologies.

Since crystalline copper nitride ($Cu_3N$) is insulating, it can be transformed into a semiconductor via vacancy doping. In their publication, Argyris Tilemachou et al. employ the p-type iodine doping of $Cu_3N$, with its subsequent conversion to $\gamma$-CuI, for the fabrication of $\gamma$-CuI/$Cu_3N$ p-n heterojunctions [1]. The $Cu_3N$-based p-type semiconductor is obtained via the first sputtering of Cu under $N_2$, followed by annealing under $NH_3$:$H_2$ at 400 °C in order to yield $Cu_3N$ with a cubic crystal structure. For the $Cu_3N$, two distinct maxima in differential transmission are found using ultrafast pump–probe spectroscopy; these correspond to the M and R direct energy band gaps and are in accordance with the density functional theory calculations, confirming a clean band gap free of mid-gap states. In the next step, $Cu_3N$ is gradually converted into optically transparent $\gamma$-CuI via doping with iodine at room temperature, resulting in hole densities of around $10^{17}$ $cm^{-3}$, a charge carrier mobility of 12 $cm^2$/Vs and room temperature photoluminescence at 3.1 eV, corresponding to its direct energy band gap. The fabricated $\gamma$-CuI/$Cu_3N$ p-n heterojunctions reveal rectifying current–voltage characteristics. However, no photocurrent could be observed due to the short lifetimes of the photo-generated electron–hole pairs in the $Cu_3N$ and/or mid-gap states in $\gamma$-CuI.

Ultraviolet photodetectors (UVPDs) are attractive electronic devices for application in flame sensors, optical wireless communication, and medical inspection systems. Wide-band-gap gallium nitride (GaN) semiconductors hold applicative promise in UVPDs due to their low excitation binding energy, which enables easy electron–hole separation under light illumination. In their paper, Pargam Vashishtha et al. fabricate GaN/aluminum nitride (AlN) heterostructures to study the impact of AlN buffer layers on the opto-electronic behavior of GaN-based UVPDs [2]. The heterostructures are obtained by growing the AlN buffer layer on a Si (111) substrate at different temperatures, followed by GaN deposition via plasma-assisted molecular beam epitaxy. The AlN layers grown at 770 °C are more stress-relaxed in comparison to those grown at higher processing temperatures, inducing a nano-obelisk GaN-like morphology. The GaN/AlN/Si heterostructures are exploited as photodetectors with a metal–semiconductor–metal geometry. The corresponding nano-obelisk GaN-based devices exhibit an improved performance, with a responsivity of 118 $AW^{-1}$. The publication emphasizes the importance of ensuring the quality of the GaN film growth by controlling the deposition of the AlN buffer layer for GaN-based UVPD devices.

Silicon carbide (SiC) thin films exhibit high potential in power electronics, micro-electro-mechanical systems, and quantum and nonlinear photonics. In their contribution, Alain E. Kaloyeros et al. fabricate stoichiometric SiC films via thermal chemical vapor deposition using 1,3,5-trisilacyclohexane (TSCH) precursor on c-Si (100) substrates [3]. The 1:1 Si/C ratio of the as-deposited films is proven with X-ray photoelectron spectroscopy and Fourier-transform infrared spectroscopy (FTIR). FTIR and photoluminescence spectrometry studies confirm the fabrication of defect- and H-free SiC films, properties that are essential to the attainment of high reliability in electronics. It is also proven that TSCH can serve as a single-source precursor for the growth of stoichiometric SiC films without the need for post-deposition thermal treatment.

In an identical context for another type of SiC polytype, Ivana Capan and Tomislav Brodar provide a review concentrating on common majority and minority charge carrier traps in n-type 4H-SiC materials [4]. The review is focused on junction spectroscopy studies, whereby the basic principles of these methods are discussed. In particular, deep-level transient spectroscopy (DLTS), Laplace DLTS, and minority carrier transient spectroscopy enable the charge carrier traps in n-type 4H-SiC materials to be identified and better understood.

In another review, Amir Dayan et al. discuss the mechanisms of dissipative losses and the sources of passive nonlinearities in the contacts and joints of conductors with rough surfaces [5]. The authors separate the physical mechanisms into three main groups, namely (i) electrical, (ii) thermal and (iii) mechanical effects, and reveal that the mechanisms are intrinsically connected but that their time scales significantly differ. Electromagnetic interactions at metal–insulator–metal junctions are rapid. Due to the speed limitations of heat in the conductor contacts, thermal processes are slower. Mechanical deformations are the slowest processes among the mechanisms. The authors reveal that losses and nonlinearity in contact joints are significantly controlled by the roughness of the contact surfaces.

The articles in the Special Issues “Feature Papers of Electronic Materials” and “Papers of Electronic Materials II” provide broad and valuable insights into the utilization of inorganic semiconductors in electronic applications and pave the way for the continued development of novel semiconductors and related technologies.

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**Conflicts of Interest:** The author declares no conflict of interest.

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