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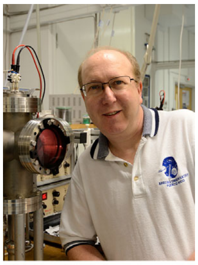
Recent Advances in Diamond Science and Technology

Paul W. May, Paulius Pobedinskas, and Shannon S. Nicley

It is our privilege to present this Topical Section of *physica status solidi (a)* highlighting recent advances in diamond science and technology. In the last decade, research on the deposition and applications of lab grown diamond has made rapid progress and is beginning to find real commercial success. In particular, lab grown gemstone diamond has now become a commercial reality, with many companies in China, India, Singapore and the US now making large quantities of gem-quality diamond for the jewellery market. Now, more than ever, the need for fundamental science underpinning the understanding of diamond deposition conditions, and the knowledge of how to distinguish the differences between natural and lab grown diamond, are more apparent. For technological applications, great progress has been made studying defect centres, such as the NV, SiV or GeV centres in diamond, which offer the promise of a range of quantum devices, from highly sensitive magnetometers to quantum computing. In parallel with this, the development of high-power device applications of diamond continues to grow, helped by the formation of a number of multi-group consortia around the world dedicated to this aim. Diamond is also being developed for use in medical diagnostic sensors, especially as dosimeters for various novel radiation therapies. Patterning and engineering the chemical properties of diamond surfaces is also a flourishing research topic, as these technologies pave the way towards advanced applications of diamond, such as solar power generation, Raman laser fabrication, ultra-fast diamond FETs, and a host of bio-applications where selected biomolecules, such as proteins or DNA can be covalently grafted onto a diamond surface. Nanodiamond particles are also a topic of great worldwide interest, as their bioinert nature, combined with fluorescent colour centres, makes them ideal candidates for biomarkers and cell labeling, as well as targeted drug delivery.

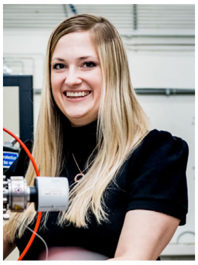


Paul W. May

In this issue, we are pleased to highlight as the front cover the Feature Article by Michael Geis and co-workers, on the topic of diamond high power field-effect transistors (FETs).[1] Diamond's exceptional properties such as the highest room temperature thermal conductivity, high hole and electron mobilities, and high breakdown electric field strength, predict that diamond FETs would have superior high-power and high-frequency performance compared to other semiconductors. The realization of diamond FETs has been limited, however, by a lack of high quality substrates, and the high ionisation energy of dopants. Recent progress has been made in these areas, including heteroepitaxial growth of single crystal diamond substrates and the use of surface p-type conductive layers. This article reviews this work and the outlook for FET and substrate development.

Paulius Pobedinskas

We hope that this Topical Section on "Recent Advances in Diamond Science and Technology" will both increase the basic knowledge of the field and inform future research strategy. We believe that this encourages not only the diamond community but also related and complementary research fields.



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[1] M. W. Geis, T. C. Wade, C. H. Wuorio, T. H. Fedynyshyn, B. Duncan, M. E. Plaut, J. O. Varghese, S. M. Warnock, S. A. Vitale, M. A. Hollis, *Phys. Status Solidi A* **2018**, *215*, 1800681.

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