Editorial: Closing the Collection on Two-Dimensional Materials and Devices

The current Collection of invited manuscripts, representing the state of the art and likely future developments in the field of Two-Dimensional Materials and Devices, was simultaneously introduced in two sister journals, *Physical Review Applied* and *Physical Review Materials*, in March 2020 [1]. At that time, nobody anticipated that the emerging COVID-19 virus would spread so rapidly and bring so many endeavors around the globe to a virtual standstill for over a year. In spite of this unforeseen challenge, the collection has been quite a success, comprising 23 manuscripts on two-dimensional materials and devices.

It seems logical that two-dimensional *materials* should be of primary concern for *Physical Review Materials* and two-dimensional *devices* for *Physical Review Applied*. Indeed, the Collection was initiated by the Managing Editor of *Physical Review Applied* at the time, Julie Kim-Zajonz, who discussed her ideas on this project with me over two years ago. I deeply appreciate her raising the question, “What is it good for?” The important question of applicability is fundamentally different from the questions “Why is this important?” and “Why is this interesting?” that are common to all *Physical Review* journals. New two-dimensional materials are surely interesting, and their unusual properties are intriguing and quite possibly important, but, eventually, it will be the answer to the question of applicability that will keep the field of two-dimensional materials and devices vibrant and alive, or put it gently to rest.

What insight have we obtained from the works in this Collection? Most of the manuscripts focus on monolayers or heterostructures containing transition-metal dichalcogenides (TMDs), whereas interest in other systems such as monolayer boron and phosphorus seems to be diminishing. Progress has been reported on the use of gating to control conduction in quantum dots; on achieving superconductivity in two dimensions; and on controlling the preferential valley degree of freedom of charge carriers in TMDs. Interfaces between TMDs and other systems have also attracted particular attention. Substrate selection can optimize growth conditions of TMDs with high carrier mobilities. Schottky barriers for charge transport and superconducting Josephson junctions occur at particular TMD-metal interfaces. Magnetism in two-dimensional systems has been reported to depend on strain, composition, and contact with a topological insulator. Also, the moiré magnetic field and flux lattice in TMD homobilayers can be tuned by strain. Understanding the formation mechanisms and spatial and energetic distributions of defects in TMDs is critical, since their presence plays a key role in device performance. Defect formation is suppressed by encapsulation, as evidenced by narrowing of the excitonic linewidth and perfect optical absorption. There is also ongoing interest in graphene mono- and bilayers, especially when their electronic structures have been modified by patterning or gating. This may yield tunable resonators or artificial metamaterials with unusual optical response and a valley-selective Klein tunneling barrier, enabling application in distributed Bragg reflectors.

Most of these contributions are put into perspective in an *Outlook* section that presents the authors’ view of the future, and may be used as guidance for advancement of the field. In closing, I thank the many contributors who made this Collection of articles on Two-Dimensional Materials and Devices possible.

[1] Editorial: Collection on Two-dimensional Materials and Devices, Phys. Rev. Appl. **13**, 030001 (2020) and Phys. Rev. Mater. **4**, 030001 (2020).

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Collection on “*Two-dimensional Materials and Devices*”

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