Frontiers of Bandgap Engineering in 2D Electronics

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Modern industries are pivoted around the latest developments in solid state electronic devices. The scope of which could not be any broader with applications in future energy, sustainability, and modern electronics. This is more evident most recently with advanced countries pledging significant funds building infrastructure to advance capabilities in this field. Among the key components in the design of such electronics is the bandgap, which is considered the electronic map of how these devices will behave in real life. One of the crowning achievements of 2D materials is their celebrated ability to leverage a high degree of control over the bandgap. In this talk, we will be covering concepts afforded with 2D materials in tailoring the bandgap as well as present the latest theoretical concepts that aim to better understand and predict the electronic behavior in the 2D realm compared to bulk[1]. The impact of number of layers, orientation, phase, stacking order, electric fields, and alloying[2] will be covered. Heterostructure band alignment theories will be discussed, along with models[3] to better predict expected band structure formations. Elemental doping effects on bandstructure and transport will be presented[4]. This talk will provide a fascinating insight into one of fastest developing fields for advancing the competitiveness of solid-state devices.

References

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Figures

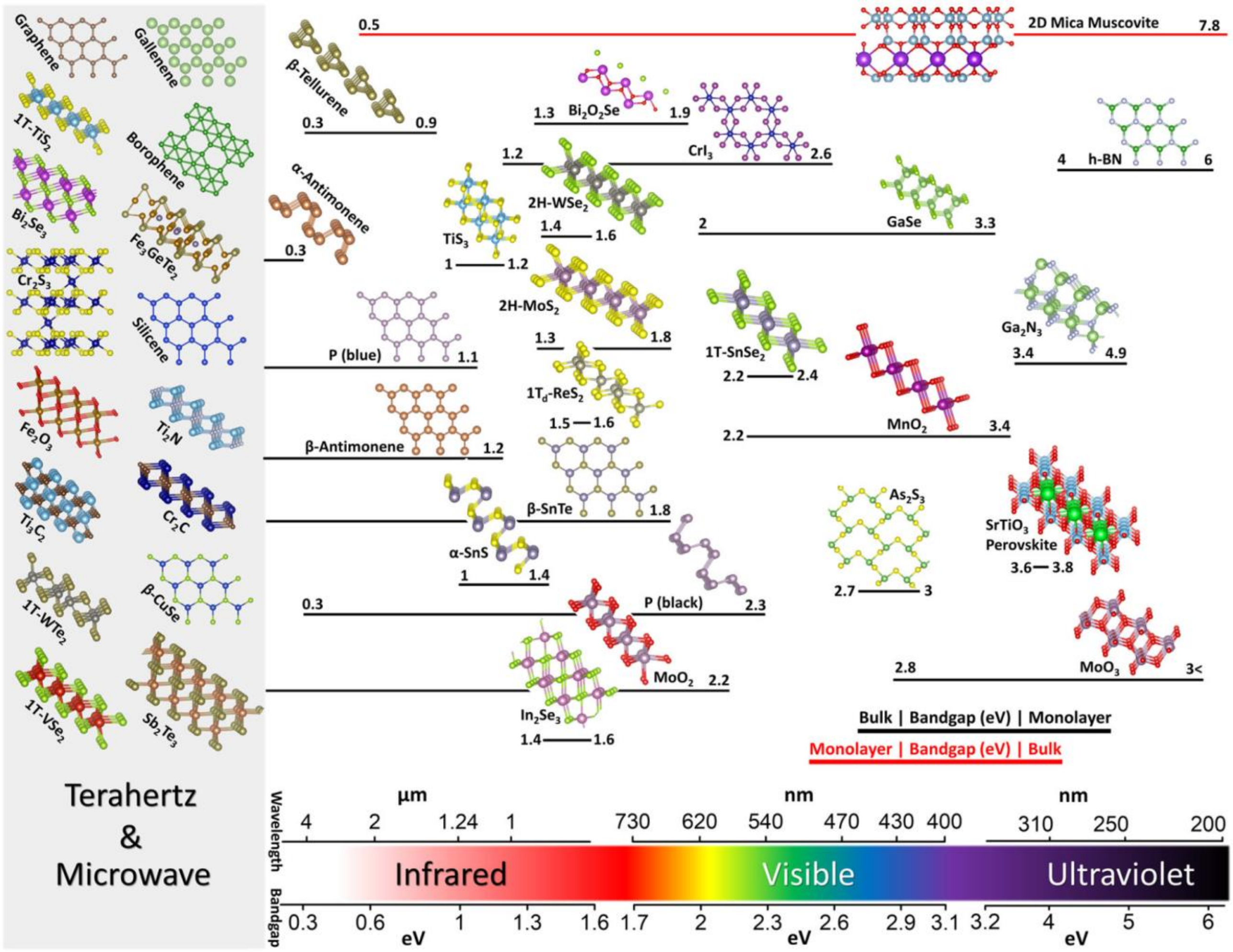

Figure 1: Selected family of 2D materials and their bandgaps. 2D materials are chosen for their experimental significance and demonstration, with depictions of a perspective view of their crystal structures. Arrangement is in accordance with their bandgap, guided by the bottom wavelength/bandgap scale, whereas the bar beneath each structure indicates bandgap range from bulk to monolayer. Typically, the bulk bandgap is smaller than that of its monolayer (black bars), but there are exceptions (red bars). 2D materials on the far left, indicated by a gray box, are zero or near-zero bandgap, metallic, or semimetallic.