Harmony of two-dimensional materials: will metal oxides join the family?

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Recent invention of graphene has initiated a completely separate field in material science – two-dimensional (2D) materials. Such materials are only one atomic layer thin crystals and may therefore host diverse quantum phenomena. This grant them consequently, totally new and unique properties, never met in a "bulk" materials before. Success of graphene has stimulated further research and at present there is a whole library of 2D materials[1].

The beauty of 2D world is that existing 2D materials can be combined into a stacks of sheets with van der Waals forces in-between, thus, designing the artificial crystals and completely new materials with predefined – programmed properties. Later is so called 2D Van der Waals Heterostructures[2] (2D HEX). This approach potentially enables new applications in such significant fields as nanoelectronics, optoelectronics, energy storage and solar cells.

Interesting, that Functional metal OXides (FOX) in two-dimensional configurations are completely unexplored field. Only a few theoretical and trial studies exist until present and it is still a mystery, whether it is possible to obtain the FOX in 2D configurations and what properties they will possess. I will tell about the recent progress in the 2D FOX field: the main limitations and problems of materials synthesis and how one can overcome them. The case of integration of ZnO films with the "oldest" 2D material – graphene will be presented and the phenomena occurring inside of this material system will be demonstrated. Further, we will answer the question whether we can combine FOX with "classic" 2D materials and what can be the benefits of it. Finally, we will conclude if 2D FOX will be able to complement the existing library of 2D materials and eventually join the 2D materials family.

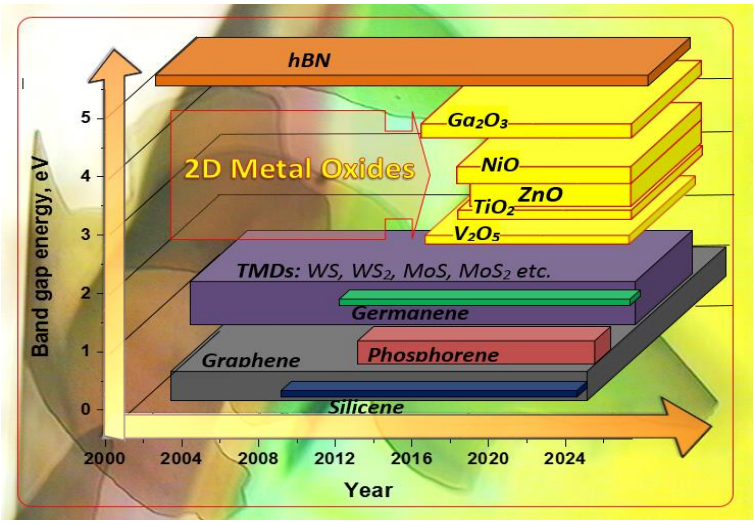

Figure 1. *Illustration of the 2D materials family time evolution (horizontal axis) and their respective band gap (vertical axis). The wide band gap range (~2.3 – 4.9 eV) can be covered by the expected 2D FOX materials. Background: exfoliated ZnO film grown on Gr/SiC*

References

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