VIDEO ARTICLE

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Research on Integration of Two Dimensional Materials in Resistive Switching Devices

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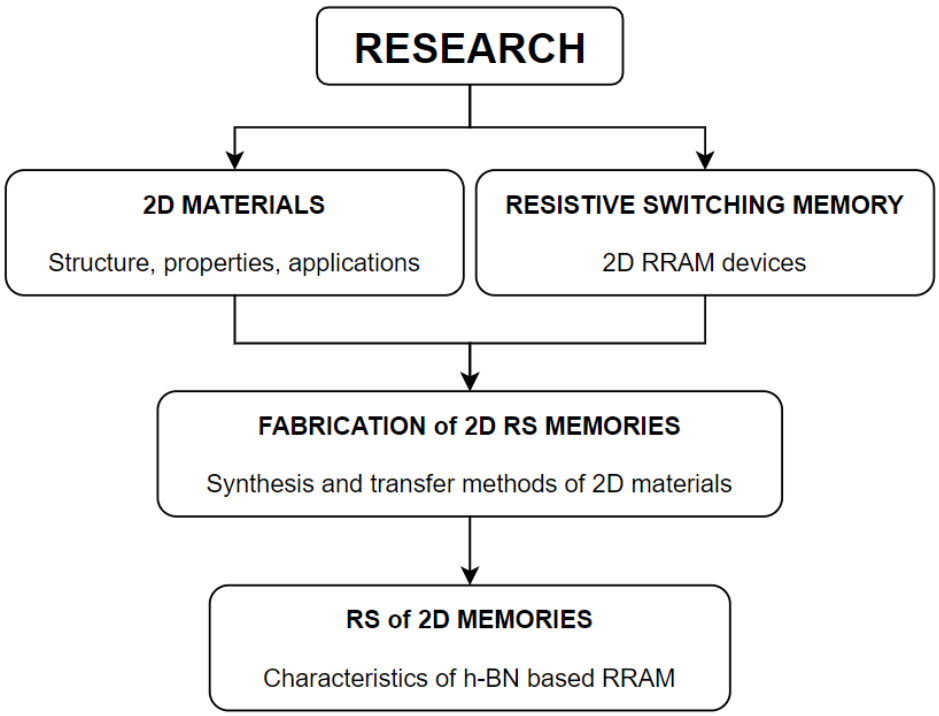
Graphical Abstract



Abstract

The interest on 2D materials are growing every day due to the discoveries of their benefits on many areas. Their unique structures create useful properties for many electronics related applications. The right choice of material can change the device properties significantly. This study is focused on BN based nanomaterials, especially h-BN. One of the most important potential of 2D materials is in the resistive switching memory devices, which were gained attention after the discovery of memristors (RRAM). Fabrication of such devices require the research on synthesis and transfer of 2D materials

used for them. For large yield synthesis, CVD is defined as the most suitable option. Here, RRAM is suggested to be the most efficient alternative as a non-volatile memory. The results of this research show that h-BN based RRAM is the best current alternative to work with even though future improvements are still necessary.

Potential of 2D materials became apparent thanks to the research on graphene as well as methods of synthesizing, transferring, detecting, characterizing and manipulating all layered van der Waals (vdW) materials [**1**]. Initially, among others, boron nitride (BN) ended up in a unique position due to its similar properties with graphene except having a large band gap on its main forms including nanosheets (BNNSs), nanoribbons (BNNRs), nanotubes (BNNTs), and nanomeshes (BNNMs) [**2**]. Nanosheets have micrometer dimensions in plane and their thickness can be around a nanometer which corresponds to only three atomic BN layers [**3**]. Having low dimensions is important on especially electronics applications. Major semiconductor companies are interested on scaling of silicon-based electronic devices. Many researches have been also done on semiconductor technology to have an economic and fast solution of thinning silicon for integrated circuits [**4**]. However, as traditional silicon-based technology is reaching its physical limits, 2D materials offer a more efficient solution for this. Studies investigated physical and chemical properties of 2D materials to use in insulators, semiconductors, metals and so on. Moreover, 2D materials can be incorporated into technologies such as ones composing the Internet of Things (IoT) hardware where the thresholds for high-performance are less stringent, and properties like energy efficiency, multifunctionality, and low costs are demanded. Addressing new approaches for computing power, data-storage capacity, thermal management, communication speeds, reliability, complementary metal oxide semiconductor (CMOS) processing compatibility and energy delay benchmark (processing speed and thermal management) is crucial. Unfortunately, although few 2D materials vendors exist, currently the large-scale manufacturing is in early stages because the largest customer base is research and development laboratories which is not enough [**5**]. In this paper, the review of 2D materials with the focus of hexagonal boron nitride (h-BN) and resistive switching (RS) memory devices were conducted as well as their fabrication and transfer methods for the purpose of technological advancement on current applications.

Keywords: 2D materials; h-BN; resistive switching; RRAM.

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Biography of Presenting Author

Ozan Dengiz received B.Sc. degree in electrical and electronics engineering from Özyeğin University, Istanbul, Turkey, in 2017. He worked in local IEEE branches and trained in mechatronics with FESTO during the studies. His experiences include 3D technologies and hybrid electrical vehicles with different companies. Part of his master's degree studies were conducted in RWTH Aachen University, Aachen, Germany. His interests include mechatronics, robotics, electronics, and materials engineering. He is currently working on his thesis to get his M.Sc. in mechatronics engineering from Tallinn University of Technology, Tallinn, Estonia.

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