

# Applications of MoS<sub>2</sub> as a Two-Dimensional Material Beyond Graphene

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An article usually includes an abstract, a concise summary of the work covered at length in the main body of the article.

## I. INTRODUCTION

## II. GRAPHENE AS A NEW TWO-DIMENSIONAL MATERIAL

### A. The Discovery of Graphene

By the end of the last century microelectronics had revolutionized the world, the majority which are silicon-based devices. Today, millions of these silicon-based devices are used in many common electronic devices and have become unavoidable throughout everyday life. Though the first field-effect device was patented in 1925, it was not until 1960 that the first metal-oxide semiconductor field effect transistor was demonstrated [5, 7, 13]. A decade after the first device, devices were being made with several thousand components on a single chip. From there the progress increased at a rapid rate, a process now known as Moore's law, predicting that for each new generation of memory chip and microprocessor unit, the device size would be reduced by 33%, the chip size would be increased by 50%, and the number of components on a chip would quadruple every three years [9, 13]. This proven to be true, and up until recently had shown no signs of stopping. Many times the material limitations were overcome by advances in technology that were seemingly insurmountable and effectively had placed a cap on Moore's law, which ultimately led to new techniques and even more pristine silicon-based materials. However, the limit to oxide thickness has finally placed a maximum on the growth of the silicon-based semiconductor device industry [13]. This impending limit caused many to look for solutions that involved the use of SiO<sub>2</sub> devices and also alternatives to silicon. The result of the latter has given way to a breadth of literature and research that was unforeseen a decade before. The search for alternatives to silicon resulted in research into many new, nontraditional materials. Several notable examples are organic conductors and carbon nanotubes [1, 2]. Arguably one of the most interesting nontraditional materials to come out of such research was graphene.

In 1985, with the discovery of fullerenes the amount of known carbon allotropes increased [6, 8]. Fullerenes suggested the existence of a one-dimensional form of carbon, known as carbon nanotubes, which were first demon-

strated in 1991 [4]. Despite several theoretical studies

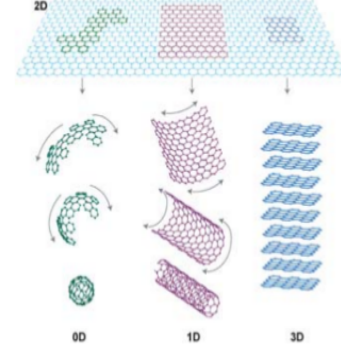


FIG. 1. Graphene can be envisioned in several dimensions. 0-dimensional buckyballs, 1-dimensional nanotubes, or 3-dimensional graphite (Taken from [8], originally found in [12].)

involving the use of a single layer of graphite, it was not until 2004 that the first monolayer graphene sheet was isolated [10, 11]. In the most basic sense, graphene is simply a single layer of carbon atoms densely packed into a honeycomb lattice. It is used to describe properties several carbon-based materials (graphite, fullerenes, nanotubes, etc..., see Fig.1) [3, 10, 14]. This was significant because scientists had tried for many years to synthesize monolayers of graphite, though only succeeding in obtaining materials around 10 layers thick [8].

### B. Properties of Graphene

## III. TRANSITION METAL DICHALCOGENIDES

### A. Properties of MoS<sub>2</sub>

## IV. SYNTHESIS METHODS

## V. APPLICATIONS OF MOS<sub>2</sub>

## VI. STATE OF THE ART

## VII. PROBLEMS AND OUTLOOK

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