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Two-dimensional Tungsten Diselenide Field-effect Transistors Using Multi-layer Palladium Diselenide as a Contact Material

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Abstract

This article delves into the promising realm of Two-Dimensional Tungsten Diselenide (2D-WSe2) Field-Effect Transistors (FETs), particularly focusing on the utilization of Multi-Layer Palladium Diselenide (ML-PdSe2) as a contact material. The investigation explores the significance, challenges, and advancements in this field, encompassing the properties of 2D-WSe2, the role of contact materials in FET performance, and the potential of ML-PdSe2. Through an extensive literature review and critical analysis, this article aims to elucidate the current state-of-the-art, highlight key findings, and provide insights into future directions for research and development in 2D-WSe2 FETs employing ML-PdSe2 contacts.

Keywords: Two-dimensional tungsten diselenide • Contact material • Field-effect transistors

Introduction

The advent of Two-Dimensional (2D) materials has revolutionized the landscape of semiconductor technology, offering unique properties and opportunities for novel device architectures. Among these materials, Two-Dimensional Tungsten Diselenide (2D-WSe2) has emerged as a prominent candidate for various electronic applications due to its remarkable electrical, optical, and mechanical characteristics. In particular, 2D-WSe2 Field-Effect Transistors (FETs) have garnered significant attention owing to their potential for low-power electronics, flexible electronics, and beyond. However, the performance of 2D-WSe2 FETs is intricately linked to the choice of contact materials, which play a crucial role in determining device characteristics such as contact resistance, carrier injection efficiency, and overall device performance [1].

Literature Review

The literature surrounding 2D-WSe2 FETs highlights the multifaceted nature of contact materials and their impact on device performance. Traditional contact metals such as Titanium (Ti), Platinum (Pt), and gold (Au) have been widely explored in the context of 2D-WSe2 FETs, demonstrating varying degrees of success and limitations. While these metals exhibit good electrical conductivity and compatibility with semiconductor processing techniques, they often suffer from high contact resistance and Fermi level pinning, leading to suboptimal device performance, particularly at scaled dimensions [2].

In recent years, the quest for alternative contact materials has intensified, aiming to overcome the inherent limitations of traditional metal contacts. Among these alternatives, Multi-Layer Palladium Diselenide (ML-PdSe2) has emerged as a promising candidate due to its unique electronic properties and compatibility with 2D-WSe2. ML-PdSe2 exhibits a high carrier mobility, low contact resistance, and excellent stability, making it an attractive choice for improving the performance of 2D-WSe2 FETs. Several studies have investigated the feasibility and efficacy of ML-PdSe2 contacts in enhancing device performance, showcasing promising results in terms of reduced contact resistance, improved carrier injection efficiency, and enhanced overall device characteristics [3]. The integration of ML-PdSe2 as a contact material in 2D-WSe2 FETs represents a significant advancement in the field, offering the potential to address key challenges and unlock new possibilities for next-generation semiconductor devices. By leveraging the unique properties of both materials, researchers aim to realize high-performance 2D-WSe2 FETs with improved scalability, reliability, and functionality, paving the way for applications ranging from ultra-low-power electronics to advanced optoelectronic devices [4].

Discussion

The utilization of Multi-Layer Palladium Diselenide (ML-PdSe2) as a contact material in Two-Dimensional Tungsten Diselenide (2D-WSe2) Field-Effect Transistors (FETs) holds immense promise for advancing the state-of-the-art in semiconductor technology. Through an extensive literature review, it is evident that traditional contact metals exhibit inherent limitations that hinder the performance and scalability of 2D-WSe2 FETs. High contact resistance, Fermi level pinning, and poor carrier injection efficiency are among the key challenges associated with conventional metal contacts, necessitating the exploration of alternative materials [5].

ML-PdSe2 emerges as a compelling candidate for addressing these challenges, offering unique electronic properties that synergize with those of 2D-WSe2 to enhance device performance. Studies have demonstrated that ML-PdSe2 contacts enable reduced contact resistance, improved carrier injection efficiency, and enhanced device reliability, thereby overcoming critical bottlenecks in 2D-WSe2 FET technology. Moreover, the compatibility of ML-PdSe2 with scalable fabrication processes further strengthens its potential for integration into large-scale semiconductor manufacturing [6]. Looking ahead, the integration of ML-PdSe2 contacts into 2D-WSe2 FETs opens up exciting opportunities for realizing advanced electronic and optoelectronic devices. By leveraging the intrinsic properties of both materials, researchers can explore novel device architectures, optimize device performance, and unlock new functionalities beyond the capabilities of conventional semiconductor technologies. Furthermore, the synergistic combination of 2D-WSe2 and ML-PdSe2 holds promise for applications in flexible electronics, wearable devices, sensor networks, and beyond, driving innovation in diverse fields and shaping the future of semiconductor technology.

Conclusion

In conclusion, the integration of Multi-Layer Palladium Diselenide as

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a contact material in Two-Dimensional Tungsten Diselenide Field-Effect Transistors represents a significant step forward in the quest for high-performance semiconductor devices. Through collaborative efforts between researchers in materials science, device physics, and engineering, the potential of 2D-WSe2 FETs utilizing ML-PdSe2 contacts can be fully realized, ushering in a new era of innovation and discovery in semiconductor technology.

Acknowledgement

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Conflict of Interest

None.

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