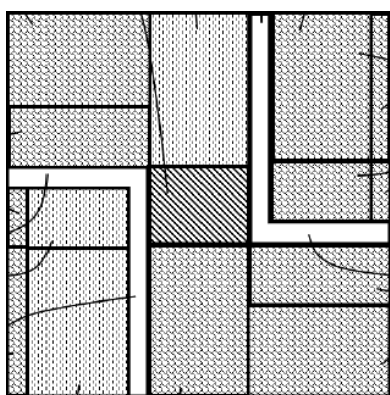


Innovative p-i-n Device Design: A Novel Approach to High-Performance Semiconductor Fabrication

Technology Description

Our invention introduces an innovative manufacturing approach for electronic devices that addresses the limitations of existing technologies. These novel devices feature a unique layered structure composed of a semiconductor material, specifically a III-V or II-VI compound semiconductor, which allows for selective p- and n-doping in a single



epitaxial step. The design eliminates the need for ion implantation or annealing to form low-resistive ohmic contacts in ap-n junction, thereby reducing defect formation. The device includes an advanced layer that integrates p-doped and n-doped regions, optionally separated by an intrinsic conductive area. This configuration allows for direct electrical contacts to the doped regions without the need for complex

access points. This drastically simplifies the manufacturing process of electronic and opto-electronic devices. Moreover, the use of our patented shadow walls technique during the deposition process enables selective growth, ensuring that only desired areas are doped while maintaining the integrity of the intrinsic layer. This method streamlines production and enhances the overall performance of the electronic devices.

Problem

Current approaches to electronic devices manufacturing, most notably for p-i-n devices, face several major challenges. Ion implantation, as an example, often introduces defects into the semiconductor material that can affect device performance. These defects can lead to lower electrical conductivity and overall reduced efficiency. In addition, the need for complex access points to contact the different layers of the device increases the complexity and cost of manufacturing. Vertical stacking of layers can also lead to shadowing effects that affect device performance, especially in light-sensitive applications such as photodetectors. In addition, the choice of materials for transparent layers is limited, which can affect the effectiveness of light-sensitive devices. Overall, these issues highlight the need for a more efficient and effective manufacturing

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Further patent filing is being pursued.

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Keywords

III-V Compound
Semiconductor, Shadow
Mask Technique, Epitaxy,
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Photodetector, P-i-n device

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process that minimises defects and improves the performance of electronic devices.

Solution

Our novel p-i-n device design offers several compelling advantages over previous approaches. Firstly, the elimination of ion implantation significantly reduces defect density, leading to improved electrical performance and reliability. The ability to achieve simultaneous p- and n-doping in a single step enhances manufacturing efficiency and reduces production costs. Additionally, the innovative design minimises shading effects, allowing for better light sensitivity in applications such as photodetectors. The direct electrical contacts to the doped regions simplify the assembly process and improve the device performance. Furthermore, the use of a compound semiconductor, particularly based on III-V materials, enables higher efficiency and better optoelectronic properties. Overall, our invention represents a significant advancement in electronic device technology, promising enhanced performance, reduced costs and exceptional manufacturing simplicity.

Potential Use

Our new approach to electronic components is suitable to transform various applications in electronics and optoelectronics. Due to the unique design, it is particularly suitable for use in field effect transistors, photodetectors, solar cells and light emitting diodes (LEDs). The increased light sensitivity and efficiency make it ideal for applications in imaging systems, telecommunications and renewable energy technologies. In addition, the simplified manufacturing process leads to low-cost production, making it attractive for mass market applications. The ability to produce high-quality, defect-free semiconductor layers opens up opportunities for advanced electronic devices, including sensors and integrated circuits. As the industry continues to search for more efficient and reliable electronic devices, this invention represents a promising alternative to existing technologies, offering both performance and economic benefits.

Development Status and Next Steps

Forschungszentrum Jülich (FZJ) has extensive expertise in this field and holds several patents. Our technology described above is continuously being enhanced. Our Peter Grünberg Institute (PGI-9) – Semiconductor Nanoelectronics – already cooperates with numerous national and international companies and scientific partners. Forschungszentrum Jülich focuses on energy and cost-efficient devices suitable for application in various emerging technologies. We are thus constantly

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seeking cooperation partners and/or licensees in this field and adjacent areas of research and applications.

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