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Optimizing Quaternary III-V Solar Cells for Indoor IoT Applications: Performance of AlInAsSb and GaInAsSb Solar Cells Under Halogen and LED Illumination

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Abstract:

The photovoltaic (PV) industry has been identified as a pivotal element in the global transition to sustainable energy sources, particularly in the context of the rapidly growing Internet of Things (IoT) industry. The IoT is a vast market comprising sensors, actuators, and wearable devices, among others. The integration of solar cells with rechargeable batteries has the capacity to eliminate expensive battery replacements and reduce the environmental damage associated with their production. A significant proportion of IoT devices operate in indoor environments under artificial lighting, which typically results in a narrower visible spectrum when compared to natural sunlight. This study adopts SCAPS-1D software, utilizing its advanced simulations to comprehensively assess the performance of diverse quaternary III-V solar cell structures, specifically AlInAsSb and GaInAsSb, in both single and tandem configurations with varying indium compositions under halogen and LED illuminations.

A detailed analysis of efficiency was conducted across a range of light intensities, highlighting the impact of temperature variations. The findings of this study demonstrate that optimized PV technologies could enhance both the sustainability and efficiency of indoor IoT applications.

Keywords: SCAPS-1D; IoT; quaternary III-V; Solar Cell; Tandem cell; Halogen; Indoor; AlInAsSb; GaInAsSb.

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