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**A NEW ELECTRONICS REVOLUTION: IMPROVING THE EFFICIENCY AND OUTPUT OF POWER ELECTRONICS CIRCUITS WITH THE USE OF GALLIUM-NITRIDE TRANSISTORS**

The integrated circuit’s invention in 1958 was undoubtedly one of the most influential events of the twentieth century [1]. Serious computing devices, which to this point had been mammoth-sized machines available only to research labs and government agencies, could now be manufactured on a smaller and more affordable scale. The integrated circuit was powered by the transistor, an electrical component made from silicon that, because of its properties as a semiconductor, could perform thousands of calculations per second [2]. Since its invention, transistors have become smaller and more powerful, allowing for an exponential increase in the processing power of integrated circuits.

However, innovation in transistors is rapidly approaching its physical limit. The most recently developed transistors are seven nanometers wide, close to the size of an individual silicon atom [3]. Because there exists an insatiable desire for improved computing power in government, business, and academia, companies and research groups have turned to other materials through which the nature of the transistor can be redefined [3].

Researchers at the Massachusetts Institute of Technology (MIT) have recently perfected a compound called gallium-nitride for use in transistors [4]. Gallium-nitride had existed as a potential replacement for silicon for many years, but lacked the full functionality of silicon in integrated circuits [5]. The MIT research team was able to alter the conventional process by which these transistors are made, therefore changing the resulting properties of the material [4]. These gallium-nitride transistors, with a fraction of the resistance of their silicon counterparts, allow electricity to flow more freely, increasing the energy-efficiency and the output of the circuit [6]. As it stands, gallium-nitride transistors present one of the most effective methods of replacing silicon transistors, launching a new era of innovation in electronics.

Our paper will focus on how transistors work, the process by which gallium-nitride transistors are made, and the properties this process confers upon the transistors that make them a more effective component in integrated circuits than silicon transistors. We will then expand our approach to examine the macroscopic benefits that are brought about by the minute differences between the two types of transistors, such as reduced energy usage and greater power output from a given circuit. Finally, we will provide specific examples of technologies that will be improved in some capacity by gallium-nitride transistors; namely, electric cars and data centers.

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**TOPIC AREA: COMPUTER ENGINEERING**

We believe that our paper has elements that are consistent with multiple topic areas of the conference, as is true with many areas of interest within engineering. Our paper most clearly fits into the topic of computer engineering, as improvement in computation is the precursor to our entire paper. However, we would like to embrace the multifaceted nature of this topic, and place an emphasis on its position within the realm of chemical engineering. We will accomplish this by including information regarding the elemental properties possessed by silicon and gallium-nitride transistors, as well as the chemical process by which these transistors are created.