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Magnetosensory Power Devices Based on AlGaN/GaN Heterojunctions for Interactive Electronics

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The advances in biological magnetoreception and microelectronics have promoted the vigorous development of interactive electronic devices capable of noncontact interaction and control via magnetic fields. Here, a magnetosensory power device (MPD) that integrates a magnetic film ($(Fe_{90}Co_{10})_{78}Si_{12}B_{10}$) unit into a cantilever-structured AlGaN/GaN-based high-electron-mobility-transistor is presented. The MPD is capable to not only sense external magnetic field, but also control device output power with the emulation of magnetoreception. Specifically, the device can achieve significant control of output power density (18.04 to 18.94 W mm^{-2}) quasi-linearly with magnetic field stimuli (0–400 mT) at a gate bias of −5 V. In addition, the maximum output power density of the MPD can reach 85.8 W mm^{-2} when a gate bias of 1 V is applied. The simulation and experimental results show that MPD has excellent orientation and magnetic field sensing functions under 0–400 mT magnetic fields. With the intelligent capabilities of magnetic sense and output power control, such interactive electronic devices will have broad application prospects in the fields of artificial intelligence, advanced robotics, and human-machine interfaces.

1. Introduction

Biological studies have suggested that a variety of animals have the ability to perceive the geomagnetic field, including insects,[1] amphibians,[2] reptiles,[3] fish,[4] and birds.[5] Migratory birds, for instance, have been suggested to not only orient themselves by sensing the inclination of the field,[6] but also may deduce their location by discerning minute local variations in the geomagnetic field.[7,8] Driven by the ongoing rapid advance of artificial intelligence (AI), neuroscience, and bionics, the development of bionic smart devices has made significant progress, such as the bionic eye,[9] artificial synapse network,[10] bionic artificial nerve,[11] bionic skins,[12] etc. The biomimetic applications of magnetoreception in nature would be an appealing source from which inspiration can be drawn to develop magnetosensory

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