nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-019-14234-7 OPEN

Strain-controlled power devices as inspired by human reflex

Shuo Zhang[1,2,7], Bei Ma[3,7], Xingyu Zhou[1,2,7], Qilin Hua[1,2*], Jian Gong[4], Ting Liu[1,2], Xiao Cui[1,2], Jiyuan Zhu[1,2], Wenbin Guo[1,2], Liang Jing[1,2], Weiguo Hu[1,2,5*] & Zhong Lin Wang[1,2,5,6*]

Bioinspired electronics are rapidly promoting advances in artificial intelligence. Emerging AI applications, e.g., autopilot and robotics, increasingly spur the development of power devices with new forms. Here, we present a strain-controlled power device that can directly modulate the output power responses to external strain at a rapid speed, as inspired by human reflex. By using the cantilever-structured AlGaN/AlN/GaN-based high electron mobility transistor, the device can control significant output power modulation ($2.30–2.72 \times 10^3$ W cm^{-2}) with weak mechanical stimuli (0–16 mN) at a gate bias of 1 V. We further demonstrate the acceleration-feedback-controlled power application, and prove that the output power can be effectively adjusted at real-time in response to acceleration changes, i.e., ΔP of 72.78–132.89 W cm^{-2} at an acceleration of 1–5 G at a supply voltage of 15 V. Looking forward, the device will have great significance in a wide range of AI applications, including autopilot, robotics, and human-machine interfaces.

[1] CAS Center for Excellence in Nanoscience, Beijing Key Laboratory of Micro-nano Energy and Sensor, Beijing Institute of Nanoenergy and Nanosystems, Chinese Academy of Sciences, Beijing 100083, China. [2] School of Nanoscience and Technology, University of Chinese Academy of Sciences, Beijing 100049, P. R. China. [3] Graduate School of Electrical and Electronic Engineering, Chiba University, Chiba 263-8522, Japan. [4] Estuarine and Coastal Environment Research Center, Chinese Research Academy of Environmental Sciences, Beijing 100012, P. R. China. [5] Center on Nanoenergy Research, School of Physical Science and Technology, Guangxi University, Nanning 530004, China. [6] School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245, USA. [7] These authors contributed equally: Shuo Zhang, Bei Ma, Xingyu Zhou. *email: huaqilin@binn.cas.cn; huweiguo@binn.cas.cn; zhong.wang@mse.gatech.edu