Seminar

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Institute for Plasma Research

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Title: Graded oxide layer for high-performing nanosized synaptic emulator

Speaker: Dr. Sudheer

Institute for Plasma Research, Gandhinagar

Date: 25^{th} May 2023 (Thursday)

Time: 03:30 PM

Venue: Join the talk online:

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Abstract

With the emergence of next-generation data-intensive technologies, future electronics are expected to replace by brain-like computing platforms. Existing commercial devices have separate processing and memory units which cause a large power consumption in data transfer and take a long time for big calculations. To resolve these problems, researchers are working on the development of a computing platform having single memory and processing unit. Fundamentally, the fabrication of a basic building block, i.e., an artificial synapse, needs to be explored to mimic the various functionalities of the bio-brain for the realization of a neuromorphic computing platform. The close emulation of synaptic plasticity in a nanosized memristive system using a single functional layer is crucial for high-performance neuromorphic computing. Here, we propose a novel and adaptive approach to constructing a single-layer-based nanosized synaptic emulator. The top surface of a reactive Ti metal layer is selectively transformed into an ultra-thin oxide functional layer (TiO_x) by adding the oxygen in a controlled manner using a plasma fireball-based low-energy ion implanter to fabricate the device. Composition gradient-based oxygen vacancy distribution produced in the active layer and their dynamics for driving bias voltage exhibit conductivity modulation. Fundamental and essential characteristics of bio-synapse, such as long-term potentiation and depression and spike rate-dependent synaptic plasticity, are confirmed at the nanoscale by employing conductive atomic force microscopy. The synaptic weight reversal in the advanced Bienenstock-Cooper-Munro learning rule is demonstrated to satisfy the need to assemble nanosized artificial synapses that mimic the various bio-functions approximately. The forming-free ability and low operating current of the device evident their potential in building power-efficient neuromorphic systems. Benefiting from the simple and cheap fabrication method of the device and excellent emulation of bio-synaptic functions offers a robust path to develop the high-performance neuromorphic architecture. The details of the work carried out and the future work will be discussed.

References:

1. W. Zhang, B. Gao, J. Tang, P. Yao, S. Yu, and M. Chang, “Neuro-inspired computing chips,” Nat. Electron., vol. 3, no. July, pp. 371–382, (2020).

2. H. Yu et al., “Evolution of Bio-Inspired Artificial Synapses: Materials, Structures, and Mechanisms,” Small, vol. 2000041, pp. 1–21, (2020).