## Surface Engineering - Applied Research and Industrial Applications
## Room On Demand - Session G4
## Pre-/Post-Treatment and Duplex Technology

**G4-1 INVITED TALK: Comprehensive Characterization of Surface Modification Mechanisms in Boron Nitride Films Prepared by a Reactive Plasma-assisted Coating Technique*, Koji Eriguchi (eriguchi.koji.8e@kyoto-u.ac.jp),*** Kyoto University, Japan*; M. Noma,* SHINKO SEIKI CO., LTD, Japan*; M. Yamashita,* Hyogo Prefectural Institute of Technology, Japan*; K. Urabe,* Kyoto University, Japan*; S. Hasegawa,* Osaka University, Japan **INVITED**

Boron nitride (BN) films are of great importance in a wide variety of engineering fields such as machinery, electronic devices, and space applications [1–4]. Various process technologies have been developed to form stable BN films. Recently, we proposed a reactive plasma-assisted coating (RePAC) system [5] to fabricate high-hardness (cubic) BN stack structures on a Si substrate and investigated the surface modification under various plasma exposures [6]. In this study, we performed comprehensive characterization of the BN films on crystalline Si substrates using various analysis techniques, *i.e.*, indentation and electrical tests in combination with a molecular dynamics (MD) simulation. The (µm-thick) BN films prepared by the RePAC system exhibited characteristic electron tunneling behaviors governed by the Frenkel–Poole effects [7][8] in response to process conditions (*e.g.* the energy of incident Ar ions). The relationship between the electrical dielectric constant determined by capacitance–voltage test and the Knoop hardness was clarified for various process conditions. An inductively-coupled Ar plasma reactor where the energy and flux of incident ions were controlled was used to investigate the surface modification mechanisms of the BN films. The formation of a surface plasma-damaged layer (a few nm thick) was identified by a nanoindentation technique [9]. The energy dependence of the sputtering yield of the BN films was compared with that of $SiO_2$ films, indicating that the BN film is one of the promising candidates for the usage in harsh environments such as a long-time plasma exposure. The MD simulations predicted the formation and reconstruction of the $sp^3$-bonded BN phase in the hexagonal background under the irradiation of ions, showing a good agreement with the experimental findings. The comprehensive characterization as performed in this study should be employed for future BN process designs.

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**G4-3 Notable Difference between Rapid-Thermal and Microwave Annealing on Ge pMOSFETs*, Fu-Yang Chu (xxmoon666@gmail.com),*** *K. Chang-Liao,* National Tsing Hua University, Taiwan*; D. Ruan,* National Tsing Hua University, China*; S. Yi,* National Tsing Hua University, Taiwan

Effects of rapid-thermal-annealing (RTA) and microwave annealing (MWA) on GeOx interfacial layer (IL) and $HfO_2$ gate dielectric in Ge pMOSFET are studied in this work. High gate leakage and low hole mobility may be

induced by diffusion of GeOx during RTA thermal process. The electrical characteristics, such as high hole mobility of ~510 cm2/V-s, low EOT of ~0.7 nm, and very low gate leakage density (JG) of ~10-4 A/$cm_2$ at VG=VFB+ 1 V

in Ge pMOSFET, can be simultaneously achieved by the efficient annealing effects of MWA on hydrogen plasma (H*) treated GeOx IL, thanks to the suppression of GeOx out-diffusion. The notable different between RTA and

MWA can be attributed to good annealing effect on gate stack with low thermal budget of MWA.

**G4-4 Characterization of Tungsten-doped InZnO Thin Films with Plasma Treatment for Conductive-bridge RAM Applications*, Chih-Chieh Hsu (cchsu.06g@g2.nctu.edu.tw),*** National Chiao Tung Universiy, Taiwan*; P. Liu, K. Gan, D. Ruan, Y. Chiu, S. Sze,* National Chiao Tung University, Taiwan

In this study, the impact of plasma treatment on InWZnO (IWZO) CBRAM was reported.In order to improve the characteristics of IWZO CBRAM device, we use oxygen remote plasma to surface-treat the IWZO layer. Oxygen plasma can slightly suppress oxygen vacancies in IWZO. The set voltage of the device becomes more uniform and smaller, which is beneficial for low power operation. The a-IWZO CBRAM shows the excellent memory performance, such as high switching endurance (up to3 ´ $10^3$ cycles) and overshoot current decrease. Without high temperature is used in the process, which would be suitable for memory in flexible substrates.

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