CHIPS Act : Semiconductor Manufacturing Science and Technologies

Room Ballroom BC - Session CPS+MS-ThP

CHIPS Act: Semiconductor Manufacturing Science and Technologies Poster Session

CPS+MS-ThP-1 Wavelength-Dependent Atom Probe Tomography of a Multilayer Dielectric Test Structure, *Jacob Garcia, Benjamin Caplins,* ***Luis Miaja-Avila****, Norman Sanford,* National Institute of Standards and Technology, Boulder*; Xiaochen Ren,* Intel Corp.*; Ann Chiaramonti,* National Institute of Standards and Technology, Boulder

Among the different analytical techniques capable of providing atomically resolved 3D structures with high chemical sensitivity, laser-pulsed Atom Probe Tomography (APT) has emerged as a promising candidate to investigate complex semiconductor devices composed of multiple layers of varying composition. The effects of using a short wavelength laser in APT have been under investigation in recent years, showing an increased survivability of Si/SiO_2/Si test structures using deep-ultraviolet (DUV; λ≈266 nm) over near-ultraviolet (NUV; λ≈355 nm) irradiation [1]. The improved sample yield using a DUV source is attributed to a more continuous and gently varying voltage curve as the sample progresses through the SiO_2 dielectric, thought to indicate a decrease in the relative evaporation fields between Si and SiO--$_2$- compared to NUV experiments. To test whether an even shorter wavelength would result in further benefits, a similar test structure was investigated on the extreme-ultraviolet (EUV; λ≈30 nm) APT system developed at NIST [2]. Comparative EUV and NUV APT experiments revealed that the apparent relative evaporation fields between Si and SiO_2 are inverted in EUV experiments, evidenced from the magnitude of the voltage curves collected under a constant detection rate. The lower apparent evaporation field of SiO-$_2$ relative to Si under EUV illumination suggests that the evaporation field may not be fully described as a material-based constant. In addition to the changes in the EUV voltage curve through the dielectric layer in this test structure, changes to the apparent background and other experimental variables important for semiconductor devices investigated using APT suggests that a single wavelength may not be ideal for every layer of a material with varying composition.

References:

1. Prosa, T., Lenz, D., Martin, I., Reinhard, D., Larson, D., & Bunton, J. *Microscopy and Microanalysis*, 1262–1264 (2021) 27-S1.
2. Caplins, B. W., Chiaramonti, A. N., Garcia, J. M., Sanford, N. A., & Miaja-Avila, L. *Review of Scientific Instruments*, 093704 1-13 (2023) 94.

Author Index

Bold page numbers indicate presenter