Thursday Afternoon, April 23, 2026

Keynote Lectures

Room Town & Country B - Session KYL3-ThKYL

Keynote Lecture III

Moderator: Sandra E. Rodil, Universidad Nacional Autónoma de México

12:40pm **KYL3-ThKYL-1 Compressive Stress as Creative Force: Engineering Ultrahard Hydrogen-Free Carbon for a Diamond-Like Properties*, David R. McKenzie [david.mckenzie@sydney.edu.au],*** University of Sydney, Australia **INVITED**

Hydrogen-free amorphous carbon films, which I first termed as "tetrahedral amorphous carbon (ta-C)", which my colleagues recently colloquially termed ‘McKenzie Material’ in recognition of my early identification and continued research of this metastable phase, exhibit extreme hardness, chemical inertness, optical transparency and tunable electronic properties. These properties are all attractive for tribological coatings, biomedical implants and microelectronic devices. Despite these advantages, scalable synthesis of dense, sp^3-rich films with sufficient thickness and adhesion has long been limited by intrinsic compressive stress and shortcomings of conventional deposition methods. Here I review recent advances in high-power impulse magnetron sputtering (HiPIMS) and its advanced variants that include mixed-mode, bipolar, hybrid-arc and multi-pulse configurations that achieve sp^3 fractions exceeding 80 %, hardness approaching 75 GPa and markedly reduced noble-gas incorporation. Precise control of pulse parameters, substrate bias and sputtering atmosphere enables tailored ion energy and flux, promoting dense tetrahedral bonding while suppressing macroparticle contamination and micro-arcing. I highlight with insights from state of the art molecular dynamics how stress generation and relaxation mechanisms operate, including sublayer implantation combined with intermittent thermal or excimer-laser annealing to relieve multi-gigapascal compressive stresses without compromising sp^3 content. Integrated strategies enable the deposition of adherent, µm-thick ta-C coatings on diverse substrates, facilitating industrial-scale deployment in wear-resistant tooling, biocompatible surfaces, and energy systems. The synergy of HiPIMS processes with targeted stress-management protocols establishes hydrogen-free amorphous carbon as a versatile platform for next-generation ultrahard, functional thin films.

Author Index

Bold page numbers indicate presenter