

## ALD & MLD on MEMS/NEMS Devices

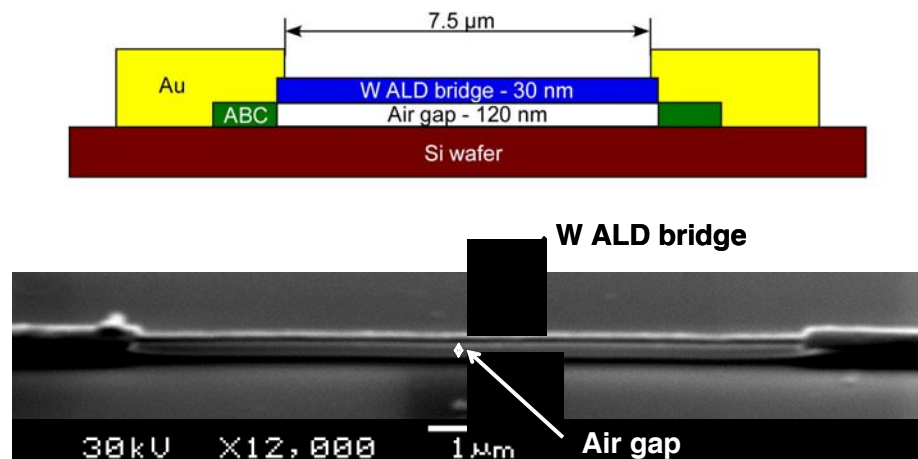
The ability of ALD to grow conformal films on high aspect structures is extremely valuable for microelectromechanical systems (MEMS) applications. ALD coatings can enhance MEMS reliability by providing protecting coatings that minimize mechanical wear [1,2]. ALD coatings can also be used to insulate, facilitate charge dissipation and functionalize the surface of MEMS devices [3,4]. Much of our research on ALD for MEMS and nanoelectromechanical systems (NEMS) is conducted in collaboration with Prof. Victor Bright's group in the Dept. of Mechanical Engineering at the University of Colorado.

ALD can also be used as a fabrication tool to create novel structures. New directions include NEMS nanofabrication using ALD and MLD. MLD can deposit precise sacrificial layers that can be removed after ALD and MLD processing [5]. The sacrificial layers become air gaps that are useful for the fabrication of

mechanical switches and bridges [5].

The accompanying figure shows a schematic representation and the SEM image of a W ALD bridge defined by a

ABC alucone airgap. ALD-coated carbon nanotubes or nanowires may also be useful for sensors for MEMS/NEMS devices.



1. N.D.Hoivik, J.W. Elam, R.J. Linderman, V.M. Bright, S.M. George and Y.C. Lee, "Atomic Layer Deposited Protective Coatings for Micro-Electromechanical Systems", *Sensor Actuat. A* **103**, 100 (2003).

2. T.M. Mayer, J.W. Elam, S.M. George and P.G. Kotula, "Atomic Layer Deposition of Wear-Resistant Coatings for Micromechanical Devices", *Appl. Phys. Lett.* **82**, 2883 (2003).
3. C.F. Herrmann, F.W. DelRio, V.M. Bright and S.M. George, "Conformal Hydrophobic Coatings Prepared Using Atomic Layer Deposition Seed Layers and Non-Chlorinated Hydrophobic Precursors", *J. Micromech. Microeng.* **15**, 984 (2005).
4. C.F. Herrmann, F. W. DelRio, D.C. Miller, S.M. George, V.M. Bright, J.L. Ebel, R.E. Strawser, R. Cortez and K.D. Leedy, "Alternative Dielectric Films for RF MEMS Capacitive Switches Deposited Using Atomic Layer Deposited  $\text{Al}_2\text{O}_3/\text{ZnO}$  Alloys", *Sensors and Actuators A* **135**, 262 (2007)
5. D. Seghete, B.D. Davidson, R.A. Hall, Y.J. Chang, V.M. Bright and S.M. George, "Sacrificial Layers for Air Gaps in NEMS Using Alucone Molecular Layer Deposition", *Sensors and Actuators A* (In Press).