Research on metals at the microscale provides vital data to advance micromanufacturing

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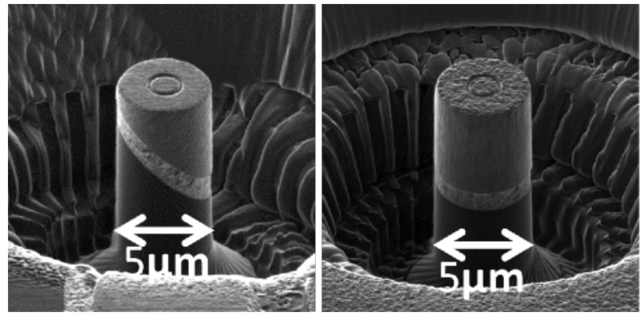
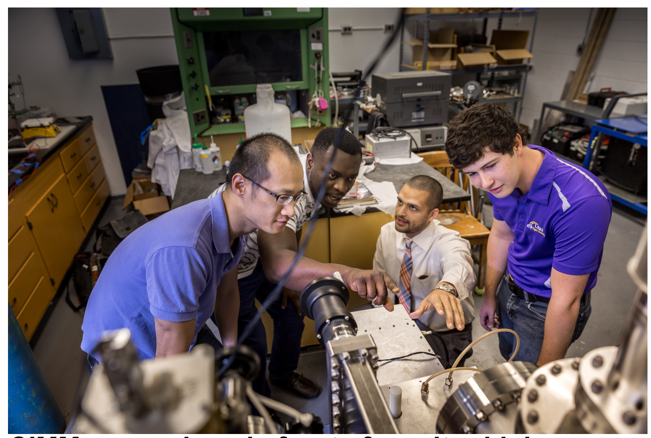
Outcome: Over the last decade, new technologies have enabled us to steadily shrink the size of many vital components in products we use daily, like cell phones and computers. Incredibly, parts are now miniaturized into sub-millimeter (thousandths of a meter) down to micron (millionths of a meter) scales. Manufacturing products at these tiny scales is very difficult because materials behave differently at this scale, requiring new understanding of the physics at play.

To help guide and accelerate the development of new micromanufacturing techniques and tools, a team of researchers led by Dr. Wen Jin Meng at Louisiana State University, in collaboration with Dr. John Hutchinson of Harvard University, is measuring how metal materials respond to deformations at the microscale.

Using a new microscale pillar test developed by this team of researchers (top picture), tiny pillars are tested to measure how copper thin films behave in specific deformation geometries. This is the first time these measurements have been made as a direct function of the film thickness and the material's microstructure.



Micro-pillar specimens for testing confined shear and normal compression of copper films. Five micrometers is about the same size as the diameter of a bacterium. Credit: Dr. Wen Jin Meng, Louisiana State University, wmeng1@lsu.edu.



CIMM researchers in front of an ultra-high vacuum thin film deposition system. Pictured, left to right: Louisiana State University (LSU) postdoc, Dr. Yang Mu, and graduate students Ukeamezhim Ayaugbokor and Mark Gabriel, both from Southern University, and Ryan Kinler from LSU. Credit: Eddy Perez, Louisiana State University, eperez2@lsu.edu.

Impacts/Benefits: Supercomputer models for plastic deformations in metals are well established at the macroscopic scales, which you can see with the naked eye. However, these models are not reliable when applied to the sub-millimeter to micron scales. The data from the pillar tests is important for understanding micron scale deformations and will directly help with the development of reliable computer models. The new models will accelerate the development of multiscale metal forming technologies that are vital to the growing advanced manufacturing industry in the U.S.

Background: Metal forming has been a mainstay of large scale mass production for decades. Metal forming at the microscale is of intense current interest in the U.S. due to continued product miniaturization trends. Developing metal forming technologies at small scales will lead to new production capabilities of components and devices.