NANO HIGHLIGHT
Science and Technology of Nanoporous Metal Alloy Films

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Our research program aims to develop the fundamental understanding and technology of thin films of nanoporous metal alloys.[1] These films have applications as coatings for biomedical devices for local delivery of therapeutic agents, adhesion promoters to join dissimilar materials, and catalytic agents for efficient fuel-cells and environmental remediation, among others. Nanoporous films are created by depositing a mixture of two or more metals, and subsequently removing one of the constituents by a selective chemical etch, a process known as dealloying.[2] The resultant film has an open-cell structure consisting of ligaments and voids with dimensions on the nm to tens-of nm scale. Our inquiries cover synthesis methods, experimental and theoretical studies of mechanical properties, and investigations of material transport.

Our recent research work has focused on synthesis and mechanical characterization of nanoporous metal microstructures. Nanoporous metals typically exhibit high yield strengths even though they have a low density.[3] However, free-standing microstructures often fail during the dealloy process, as shown in the electron micrograph in Figure 1. Here, a released nanoporous Au bridge has failed due to the accumulated residual tensile strain that develops during the dealloying process. The insets at higher magnifications show both oriented defect planes and the nanoscale porosity. Based upon the understanding of the failure mechanism, we have developed a technique for manufacturing nearly stress-free nanoporous metal bridges through a thermal annealing process. Preliminary results, Figure 2, demonstrate intact freestanding microstructures after dealloying. Further investigations are underway to quantify the dealloy-process-induced stress, with the goal of using these structures as elements in microfabricated sensors.

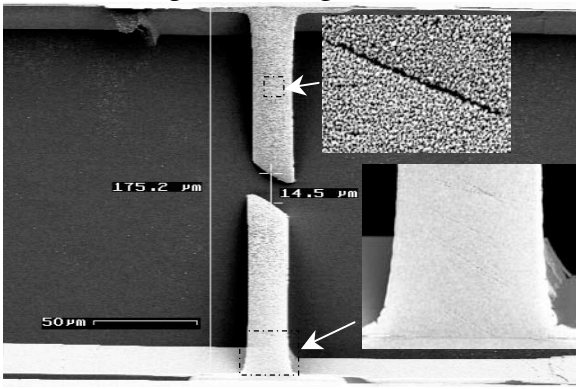

Figure 1. Nanoporous Au microbridge created by dealloying failed due to the large amount of strain created by the dealloy etch process.

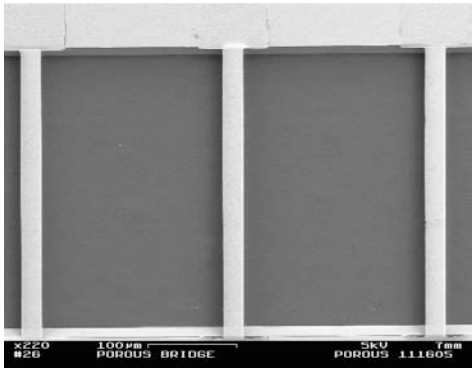

Figure 2. Intact nanoporous Au microbridge subjected to thermal prestrain process.

References

[1] For further information about this project, please contact the PI, Prof. Michael Reed, reed@virginia.edu.
[2] J. Erlebacher, M. J. Aziz, A. Karma, N. Dimitrov, and K. Sieradzki, "Evolution of Nanoporosity in Dealloying," *Nature* 410, 450-453, 22 March 2001.
[3] Juergen Biener, Andrea M. Hodge, and Alex V. Hamza, "Microscopic failure behavior of nanoporous gold", *Appl. Phys. Lett.* 87, 121908, 2005