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CHEMICALLY-INDUCED SOLID-STATE DEWETTING OF THIN GOLD FILMS

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Partially agglomerated metallic thin films deposited on ceramic substrates represent an important component of the electrode-electrolyte system in various solid-state electrochemistry applications. In particular, the electrochemical reaction usually occurs at the triple lines where the substrate, the film surface, and the film-substrate interface meet. Therefore, the total length of these triple lines should be maximized for improving the electrochemical performance of the system.

In this study, we propose a novel method of manipulating the total length of the triple lines in partially agglomerated metal thin films deposited on ceramic substrates. First, silver- gold alloy nanoparticles have been fabricated employing the dewetting phenomenon. Then, a gold layer was deposited on the particles followed by annealing at low homological temperature. During this annealing, the material of the film diffuses into the particles, which results in high area density of holes in the film.

The decreased thermal stability of the gold film is attributed to the accelerated thermal grooving process. This process is accelerated by the diffusion fluxes of Au atoms driven from the film towards the nanoparticles by the gradient of chemical potential caused by the gradient in composition.

We developed a quantitative model of this chemically- induced dewetting process. Based on our experimental results and model we are able to demonstrate that the chemical driving forces have to be reckoned with in the analysis of thermal stability of multicomponent thin films.