



HARE SQ Film Stress Reduction and Elimination of Film Cracking

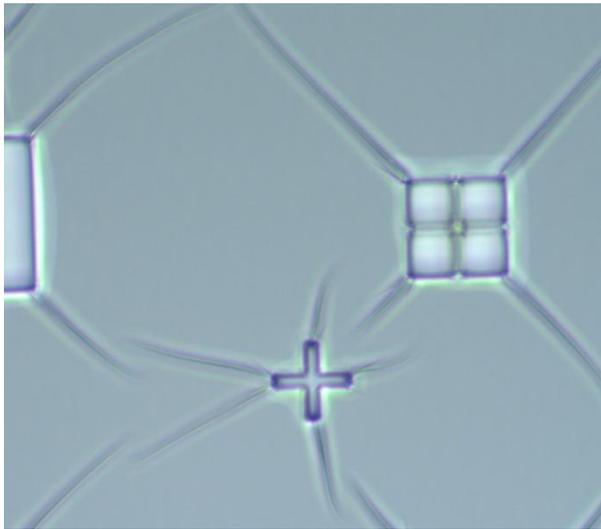
Abstract: Epoxy based resist systems such as the HARE SQ system are designed for MEMS and microfluidics applications as a permanent material designed to remain within the device. As such, the SQ film must function over the lifetime of the particular device. One of the more common failure modes of the epoxy materials are caused by cracking and adhesion loss due to excessive stress within the resist film. This document will explain the causes, consequences, and solutions, associated with stress within the resist film.

Causes: Upon spin coating, the liquid epoxy film is evenly spread across the desired substrate in a uniform coat at a nominal thickness ranging from 2 to 100+ microns. Immediately upon completion of the coating, the epoxy film, which has a low surface tension, attempts to pullback on the surface of the substrate. These forces lead to a buildup of stress within the film. The softbake process removes solvent from the film which also increases the stress within the now dry film.

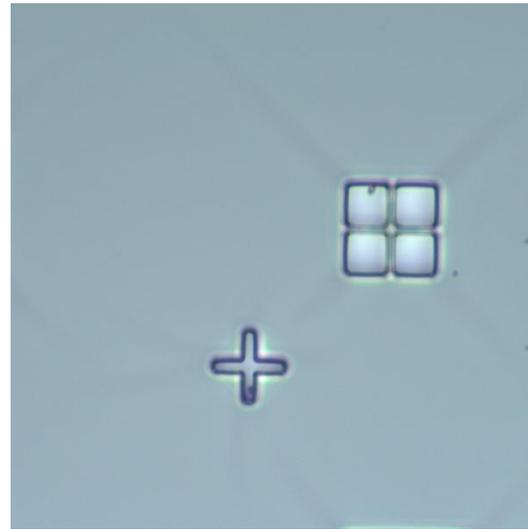
Consequences: During the imaging process, the inherent stress within the dried film has various effects on the resist features. Excessive stress at the substrate/resist interface will often result in adhesion failure and liftoff of the resist lines. When the features have sufficient adhesion to the substrate surface, the stress often manifests itself as cracks in the top resist surface. While this cracking may often be cosmetic, many times it can lead to significant failure of the devices, particularly in permanent applications.

Solutions: Two methods are available to reduce stress and eliminate cracking within the resist film and images. One involves an annealing bake to relieve the stress and allow the cracks in the film to reflow. Experimentation has shown that bakes above 110C for 5 minutes are sufficient to remove cracking in the film. Photos are shown below depicting the film at various bake conditions.

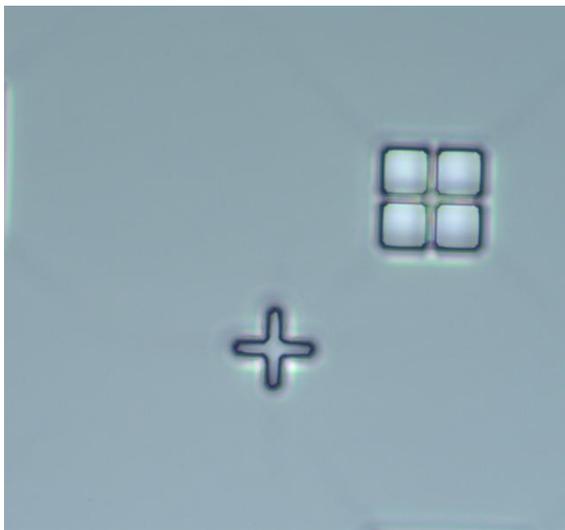
A second method uses the addition of a plasticizing material to the formulation which increases the flexibility of the epoxy film, reducing the stress within the film. Selection of an appropriate plasticizer is critical to the resist imaging and performance. This material must be compatible and miscible with the resist solvent and the epoxy resin, forming a homogeneous film upon spin coating.



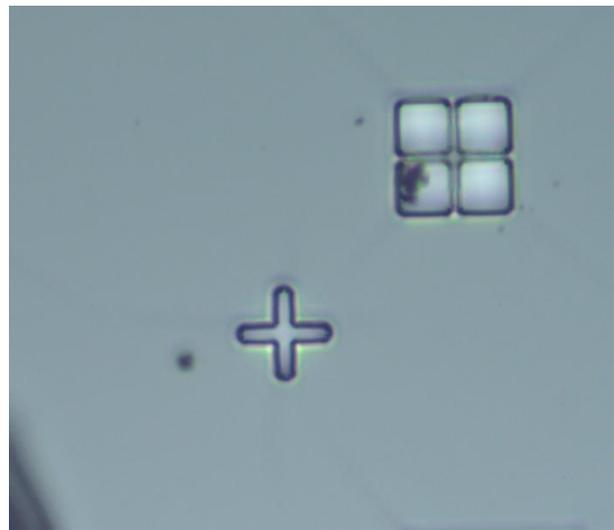
SQ-25 No Hardbake



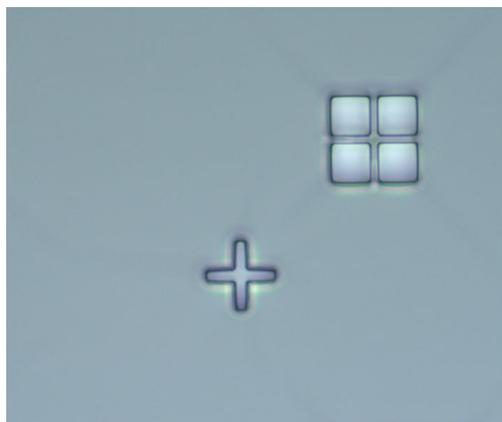
SQ-25 110C/ 5 minute Hardbake



SQ-25 120C/ 5 minute Hardbake



SQ-25 130C/ 5 minute Hardbake



SQ-25 140C/ 5 minute Hardbake