Ultracompliant Thermal Probe Arrays for High Throughput Thermal Imaging and Maskless Lithography

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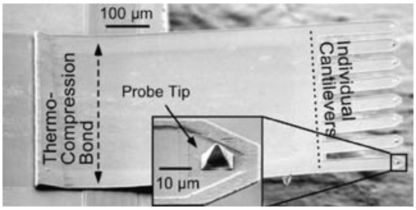

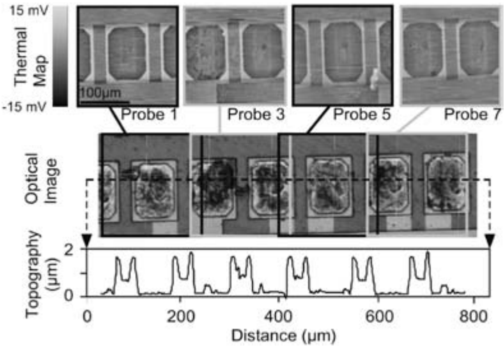

Left – SEM of the ultracompliant thermal probe array, with inset showing probe tip. Right – Composite thermal image of bond pads on a commercial IC generated from 4 probes scanning in parallel.

Scanning Thermal Microscopy (SThM) is a probe microscopy technique capable of resolving 30nm features and temperature differences in the range of 1mK. Although it can be used to image a wide range of samples, including semiconductors and biological tissue, SThM is inherently time-consuming because it requires a heated probe tip to be raster scanned across a sample. Operating multiple probe tips in parallel is a natural means to increase throughput; but, like other scanning probe techniques, SThM typically requires a force feedback mechanism to regulate the contact pressure between the probe and the sample, and thus prevent damage to both. For large multiples of probes, this is prohibitive in both cost and complexity, since an independent feedback loop and actuator is needed for each probe in the array. This project is aimed at developing thermal probe arrays capable of scanning samples without the need for force feedback or integrated actuators. This is done by using ultracompliant cantilevers which allow the probes to pass over topographic variations of several microns with a contact force 10 times less than conventional probes. In addition, this design allows the individual cantilevers in the array to deflect independently of one another, and thus the probes obtain independent images which can be combined to generate a composite. The use of polyimide or other polymers as a structural material also provides excellent thermal isolation, resulting in increased sensitivity and reduced thermal crosstalk. The probe array has also been used to thermo-chemically pattern commercially available photoresists with submicron resolution. The maskless process is the first demonstration of scanning probes being used to spatially pattern thermal cross-linking in a polymer, and therefore it offers a new avenue for patterning emerging thin-film materials. This project is supported in part by a University of Michigan grant.