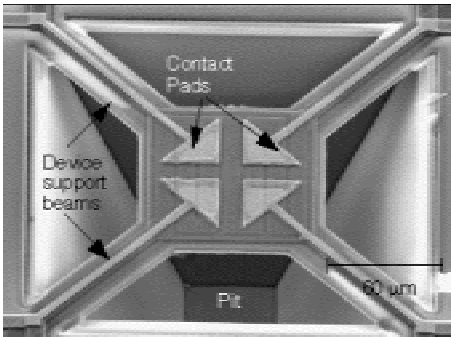
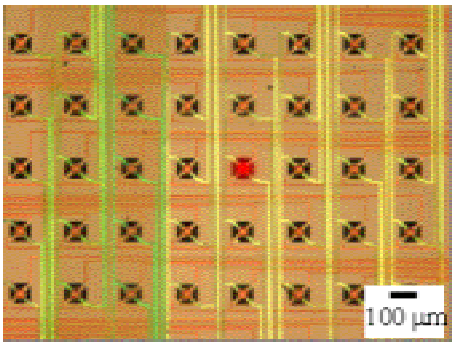
Microhotplate array platforms

- Critical Issues
  - Temperature is one of the most important parameters to control in fabricating and performance-testing materials. Parallel studies of multiple microsamples, each with its own temperature controllable substrate, can offer an efficient method for developing processing-performance correlations that permit materials optimization for a wide range of technologies, including catalysis, electronic materials, sensing, polymers, and many others.
- Research Strategy
  - Microdevices called "microhotplates" have been designed and constructed using surface-micromachining of silicon. These small (≈ 100 μm) devices can be rapidly heated (≈ ms) using built-in resistive heaters, and circuitry can also be included on each microhotplate to measure temperature and electrical characteristics of samples deposited over top-surface microelectrodes. The microhotplates can be easily replicated into microarrays with 10's or 100's of thermally isolated and individually addressable elements. The nominal temperature range is from 20 °C to 500 °C, or higher. Samples can be processed onto the microsubstrate elements under a matrix of fixed or time dependent temeperature programming, and the same methods can be used in evaluating the temperature dependent performance of the microsamples. The approach is particularly valuable for investigations that benefit from studies on discrete samples, such as one would encounter in developing improved or new catalysts. In addition to utilizing the individual control of temperature in processing and testing, one can also electronically address the microelements for localized electrochemical deposition and interrogation of on-chip sample electrical cahracteristics. Efforts are underway to expand both on-chip and external probing techniques to meet diagnostic needs in combinatorial studies.
- Research Highlights
  - Microarrays of 16, 48 and 340 elements have been constructed and used, thus far, in materials studies that relate primarily to the development of new films for solid state gas microsensors. A variety of techniques for localized deposition of microsamples have been demonstrated on microhotplate arrays, including self-lithographic CVD, addressable electrochemical deposition, drying of sol-gels and suspensions, thermal lithography, masking, and micro-pipetting. Conductive films have been electrically monitored as they grow, and this approach has been utilized for automating sample fabrication. 48-element array studies of oxide-based sensing materials have been completed which demonstrate the use of on-board control and interrogation capabilities to relate film microstructures to sensing performance.





For more information ...

Steve Semancik, Chemical Science and Technology Laboratory