Thermal Properties of Novel Thin Films in ICs and MEMS

K.E. Goodson, M. Asheghi, M.N. Touzelbaev, and K. Kurabayashi,
Y.S. Ju, B. Chui, and T.W. Kenny
Department of Mechanical Engineering
Stanford University
Stanford, CA 94305-3030 USA

The performance and reliability of modern Micro Electro Mechanical Systems (MEMS) and Integrated Circuits (ICs) are benefitting from the use of unconventional thin films, including porous oxides and polymers for low-dielectric-constant passivation, diamond films for passivation of high-power circuits, and monocrystalline silicon films in cantilevers and transistors made from silicon-on-insulator (SOI) substrates. The present work describes measurements of the thermal properties of these films together with data demonstrating their impact on microdevice temperature fields and reliability.

The measurements make use of unique optical thermal mapping techniques developed in our laboratory [1-3], including near-field optical thermometry (NFOT). NFOT overcomes the diffraction-limited spatial resolution of conventional far-field techniques by scanning a tapered optical fiber within nanometers of the sample surface. The optical techniques capture temperature fields with nanosecond temporal resolution and sub-wavelength spatial resolution, which helps to strongly localize the region within which thermal properties are interrogated.

[1] Y.S. Ju, O.W. Kading, Y.K. Leung, S.S. Wong, and K.E. Goodson, "Short Timescale Thermal Mapping of Semiconductor Devices," *IEEE Electron Device Letters* **18**, 169-171 (1997).
[2] K.E. Goodson and M. Asheghi, "Near-Field Optical Thermometry," *Microscale Thermophysical Engineering* 1 (in press).
[3] Y.S. Ju and K.E. Goodson, "Short-Timescale Thermal Mapping of Interconnects," Proceedings of the 35th IEEE International Reliability Physics Symposium, Denver, Colorado, April 8-10, IEEE Catalog No. 97CH35983, pp. 320-324 (1997).