3-omega measurements of thermal conductivities of materials for low thermal resistances

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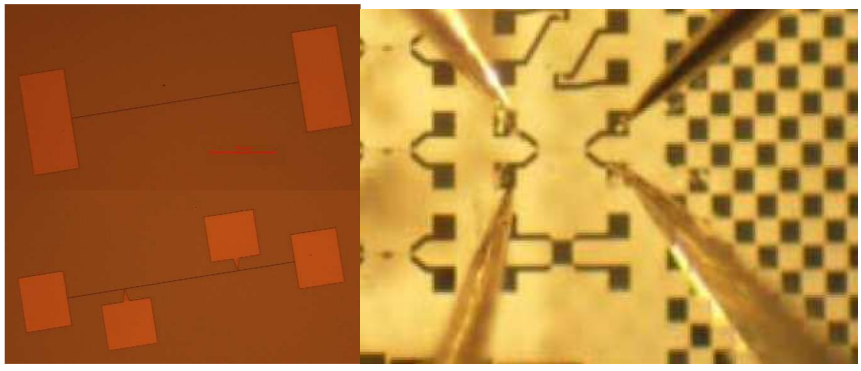
Thermal phenomena at nanometer-scale are being explored currently with great interest, as different behaviors are encountered when characteristic dimensions of the systems are approaching the energy carrier's means free paths or their wavelengths. We have implemented a new 3-omega [1] method setup that enables to measure directly the thermal conductivity. The 3-omega method has been used for the last 20 years in order to determine the thermal conductivities of bulk materials, thin films and/or nanocomposites. We discuss issues related to the sensitivity of the method to anisotropy and how to improve the accuracy. We analyze also the classic design and show that it can be modified to take fewer approximations into account in the data analysis. In particular, we discuss possible improvements of this kind of setup in comparison to photo-thermal methods.

We have measured the conductivities of different samples to be used in the microelectronic industry, such as Thermal Interface Materials and silicon-based ones. These measurements have been done as a function of temperature in the range [10-300] K, enabling to probe different regime of the phonon Knudsen number.

Reference:

[1] D. Cahill, Review of Scientific Instruments, **61** (1990) 802

Figure:



Left: *Optical microscope image of two different designs allowing for measurements with the 3-omega method.* Right: *Probes in contact with the metal design*