Synthesis, characterization and thermal evaluation of new generation of Nano-Ceramic material

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Efficient thermal management is often considered as a key step towards a successful technological system. The fast removal of excess heat from electronic systems exposed to temperature extremes improves the reliability and prevents the premature failure of these systems. Nowadays, the usual approaches to evacuate heat and maintain the system at a desired temperature consist in using a semiconductor heat sink or a complex fan speed control system that relies on continuous temperature measurement. However, the optimization of a highly efficient semiconductor heat sink requires the control of diverse intrinsic and extrinsic properties at different scale because the macroscopic thermal flow and heat transport depend on microscopic vibrational properties. Besides, widespread use of highly efficient semiconductor heat sinks requires the ability to metalize them and form multilayer structures. Due to its high phonon group velocities, Aluminium Nitride (AlN) appears to be one of the best candidates for the manufacturing of efficient semiconductor heat sinks. In this PhD. thesis work, we intend to develop a new substrate technology Metal/AlN/Metal structures with high thermal diffusivity for integrated power system for high temperature applications. This PhD. Aims at developing highly efficient, integrated and reliable power electronics technologies operating at high temperature for automotive, aeronautic, and energy.

The detection of the thermal wave propagation and speed at various special scales (from a millimeter to a few micrometers) will be carried out by using noncontact and non-destructive optical methods. We will be relying on the analytical solution of the heat conduction problem within a thin semiconductor film deposited on a semi-infinite metallic material. We will also be using a thermal wave interferometry technique that has demonstrated a high potential in measuring the contribution of the characteristics of a heat wave propagating in a system with interfaces. As a matter of fact, the propagation of thermal waves with angular frequency generated within two layers is affected by the interference by the interference between the first and second layer. In particular, thermal waves are partially reflected and transmitted at the separation surface of two different materials like conventional waves. The interference between propagating and reflected waves alters the phase and amplitude of the *ac* component interface temperature. Then, the contribution of the interface to the thermal diffusivity of the whole system can be made possible by using a lock-in detection technique.