Table #1: Summary of Thermal Resistance Measurements Conducted on a Range of Die Attach Materials used to Bond Si Chips to Alumina Substates.

MATERIALS	THERMAL RESISTANCE C/W	THERMAL CONDUCTIVITY OF "ADHESIVES" W/M-K SOLDER
Epoxy-paste Ag-filled	5.6	1-6
Polyimide-paste Ag-filled	7.2*	1-6
Ag/glass-paste	4.6	80
Acrylic-ribbon Ag-filled	6.7	1
Solder-preform	4.5	28

*Solvent containing, many possess excess voids.

Table #2: Thermal Resistance of Die to Nickel/Kovar Header Assembly.

"ADHESIVE-SOLDER"	THERMAL RESISTANCE (C/Watt)	BULK THERMAL CONDUCTION W/M-K
Solder preform	0.30	35
Silver-Epoxy	0.33	6

Table #3: Bulk Thermal Conductivity as a Function of Voids.
The "Rule–of–Mixture" does not apply in this System.

	DENSITY (gm/cc)	THERMAL CONDUCTIVITY (Watt/cm–k)	ESTIMATED % OF VOIDS
96% SINTERED ALUMINA	3.85	0.16 (measured)	0%
100% SINTERED ALUMINA	3.95	0.37	0%
SPRAYED ALUMINA #1	3.23	0.027	18%
SPRAYED ALUMINA #2	3.49	0.082	11%

Table #4: Effect of Thermal Removal Efficiency on measured Thermal Impedance.

SYSTEM	1	2	3	4
PART	Silicon	Silicon	Silicon	Silicon
HEAT SPREADER (SUBSTRATE)	Copper laminates through Thermal Vias	Copper plate	Copper	Copper
ADHESIVE USED	ME 7159 Equivalent	ME 7159 Equivalent	ME 7159 Equivalent	ME 7159 Equivalent
HEAT REMOVAL SYSTEM	Convection Only	Sophisticated, high velocity, air–flow	Flowing coolant @25C	Heat exchanger
THERMAL IMPEDANCE (C/Watt)	5.0 – 6.0	1.0	0.2	0.1

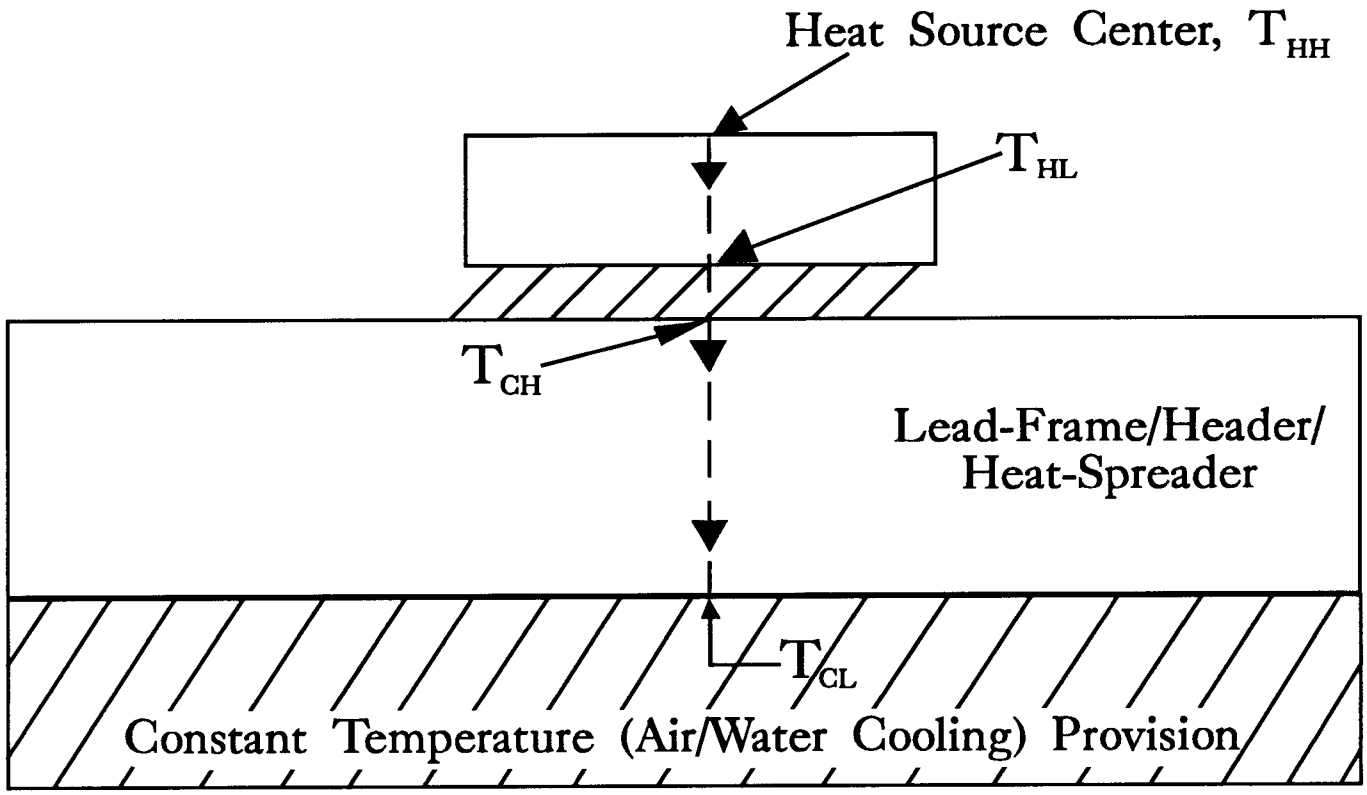

Figure #1: Schematic of an Adhesive Assembled Device

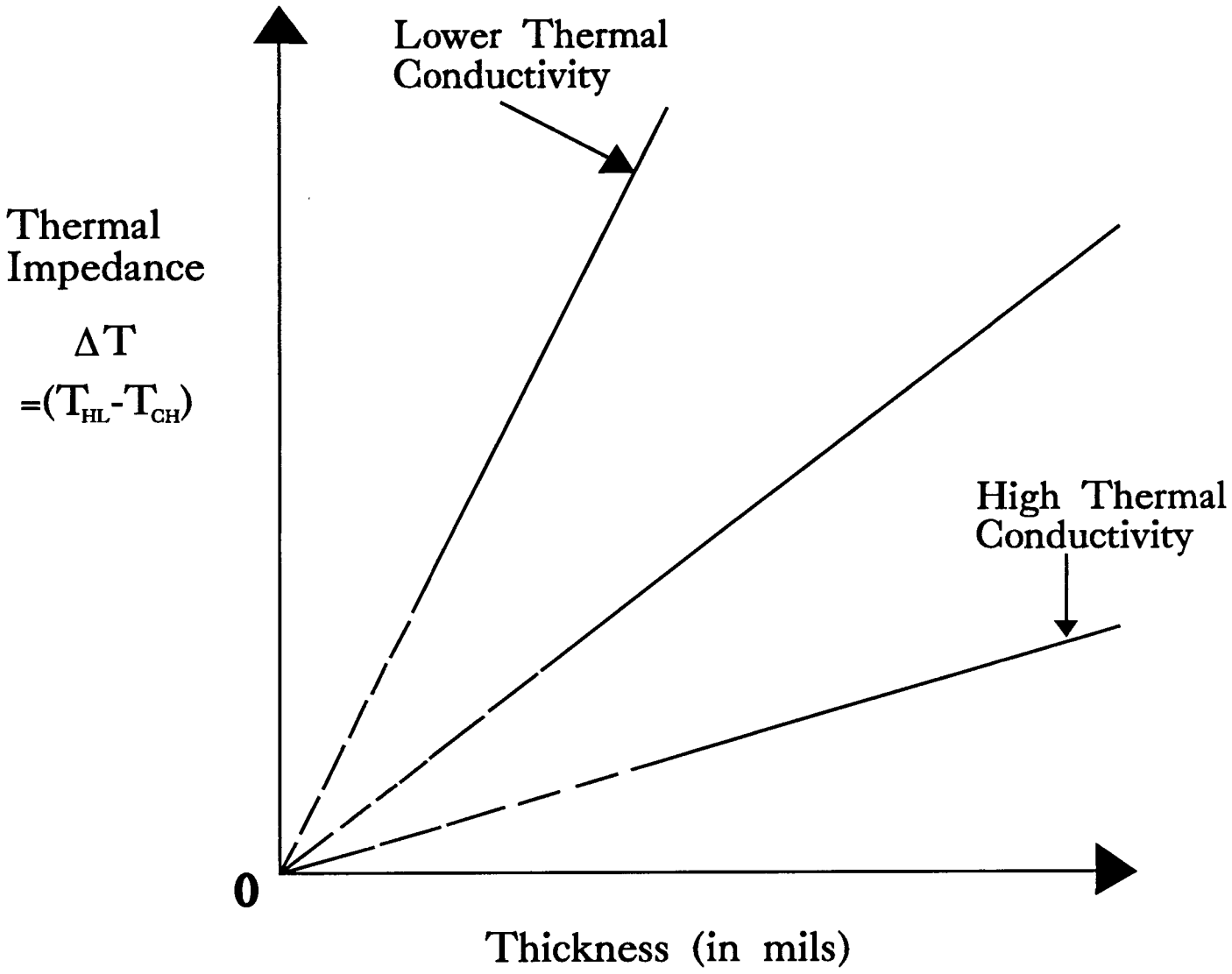

Figure #2: Theoretical Dependence of Junction Temperature of Bond-line Thickness and Thermal Conductivity of Adhesive

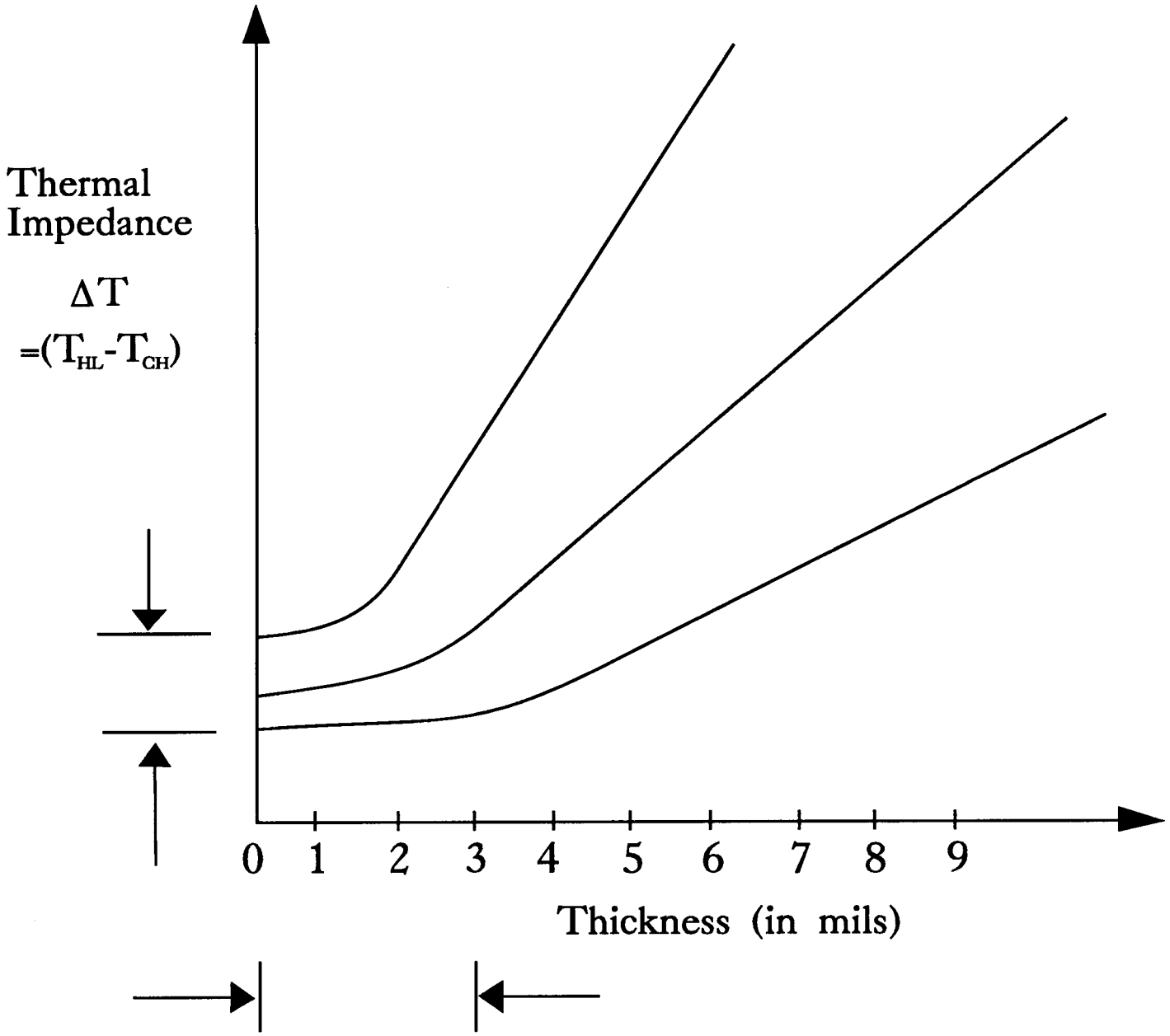

Figure #3: Thermal Impedance Effect of Interfaces in an Adhesive Assembled Electronic Device

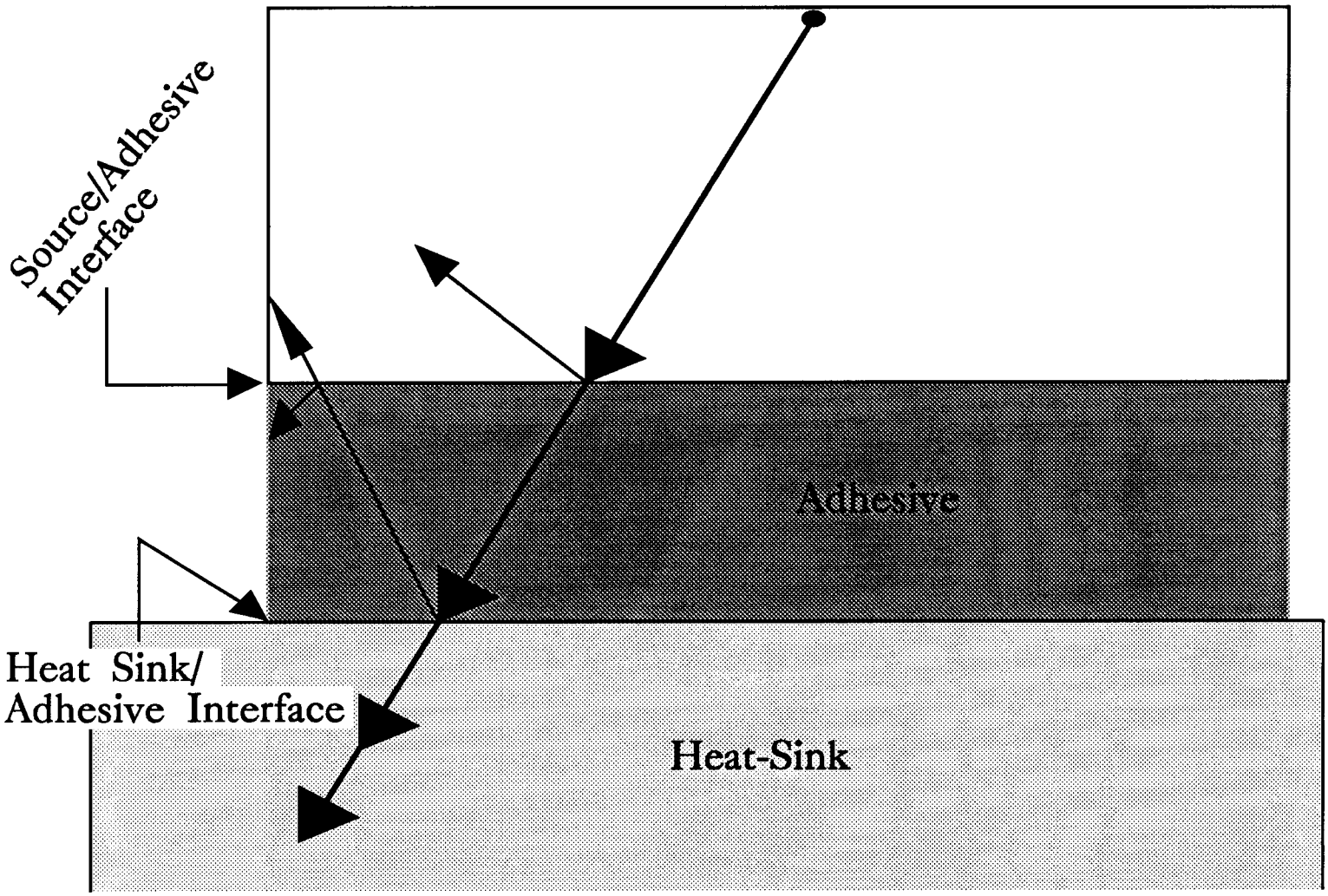

Figure #4: Schematic of Phonon Scattering at the Interfaces of an Assembled Electronic Device