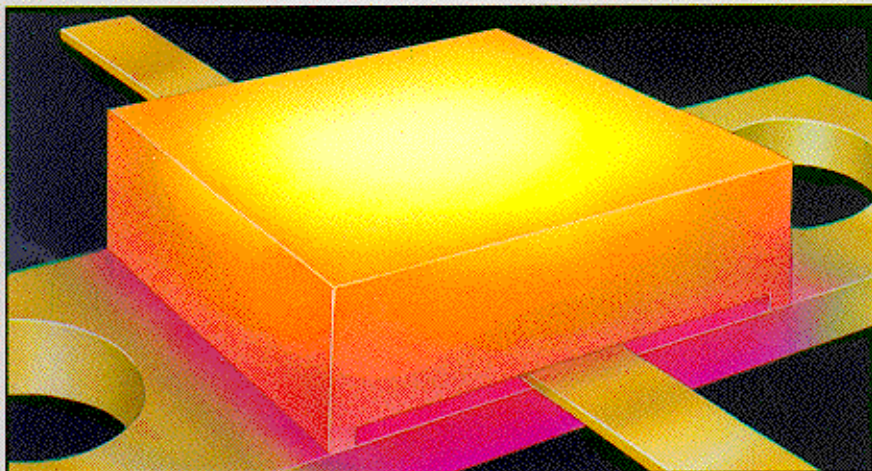


THERMKON[®]

High Performance Heat Sink Material



The heat sink material that combines thermal expansion rate with high thermal conductivity



Heat is the major cause of microsystem failure. This illustration simulates how Thermkon® solves that problem by dissipating heat from the chip at rates up to 110 BTU/h/ft²/°F or 190 w/m²/K. The degree of dissipation you require will help determine which of the Thermkon® composite materials should be used for your application.

Almost any heat sink material you specify involves a basic, unavoidable trade-off. Either you trade off high thermal conductivity for a low coefficient of thermal expansion or you sacrifice expansion for conductivity.

Either way, it does not make your job any easier. And it will not contribute to the overall reliability of your package as well as you would like.

Thermkon® high performance heat sink materials from CMW puts an end to this trade-off. Because compared to the more limited heat sink materials such as copper, aluminum or Kovar®, Thermkon® offers a better matched rate of expansion and a high thermal conductivity.

Its unique chemical composition is the reason. Thermkon® is fabricated from tungsten or molybdenum and copper in electronic grade powdered form. Tungsten or molybdenum for strength, rigidity and low controlled coefficient of thermal expansion and copper for high thermal conductivity.

The result: A composite heat sink material that meets the increasingly complex demands of the electronics packaging industry. Without trade-offs.

Here's how:

High thermal conductivity

In today's advanced electronic packaging systems, heat dissipation requirements may rise as high as 10 watts ... and perhaps higher in extreme and unusual applications.

As you can see from the Thermal Conductivity figure to the far right, all Thermkon® composite materials provide the high thermal conductivity needed for excellent heat dissipa-

tion. The greater the copper content in each Thermkon® grade, the higher level of heat dissipation. To assure not only a high but also a uniform level of dissipation across the heat sink's surface, CMW uses a special 1200 °C infiltration process to fabricate Thermkon®. This process allows Thermkon®'s high grade copper to permeate the porous sintered tungsten or molybdenum base skeleton. This results in an even distribution of copper throughout the heat sink.

To protect your system from the thermal mismatch problems that often occur with overheating, Thermkon® composite materials maintain a controlled rate of thermal expansion as they dissipate heat, even in superheated conditions.

In turn, this even distribution of copper promotes uniform heat dissipation across the entire surface of the heat sink. This reduces thermal stress on the chip and components and helps keep your system from falling prey to overheating - the number one cause of microsystem failure.

Controlled thermal expansion rate

Any significant difference in the thermal coefficient of expansion between the heat sink material and the chip - and many of the substrate materials in your package - may cause the solder joints attaching the materials, the leads, the substrates or the chips to break. And your system fails.

To help prevent this, all Thermkon® composite materials offer controlled coefficients of thermal expansion closely matching those of beryllium oxide and alumina ceramics. The

more tungsten or molybdenum content each Thermkon® material has, the lower its coefficient of thermal expansion.

Field tests show that Thermkon® materials maintain an acceptable, controlled expansion rate even in temperature extremes such as -100 °C to +500 °C ... where many other low thermal expansion materials experience severe problems.

Other benefits of Thermkon® composite materials

- **Hard solder, full contact brazes** maximize thermal transfer.
- **High electrical conductivity** thanks to high copper content.
- **Non-magnetic**, will not interfere with system polarity.
- **High density tungsten base Thermkon®** enhances radiation shielding.
- **Lower density molybdenum base Thermkon®** for weight control applications.
- **High strength and modulus of elasticity** due to high tungsten or molybdenum content. This increases the rigidity of your microsystem.

Typical uses

Because of Thermkon®'s exceptional performance characteristics, it is well-suited for almost any application requiring both high thermal conductivity and low thermal expansion.

Indeed, while other heat sink materials might exceed Thermkon® in one or the other

... provides a closely matched and controlled thermal conductivity

formance in both. It is this unique balance of high conductivity and controlled expansion that makes Thermkon® ideal for such applications as:

- Discrete flanges for NPN silicon bipolar power transistors.
- GaAs FET carriers.
- Flat pack bases to match thermal and coefficient requirements of thick and thin film circuitry.
- Machined housings for amplifiers and mixers.

Thermkon® is also ideally suited to a wide range of other applications. Consult CMW's application engineers for more information.

The benefits of powder

Most heat sinks are made from stamped metal. Thermkon® is not. It's a composite powdered metal material. That means the copper and tungsten or molybdenum in Thermkon® retain their own chemical characteristics instead of bonding together to form an alloy.

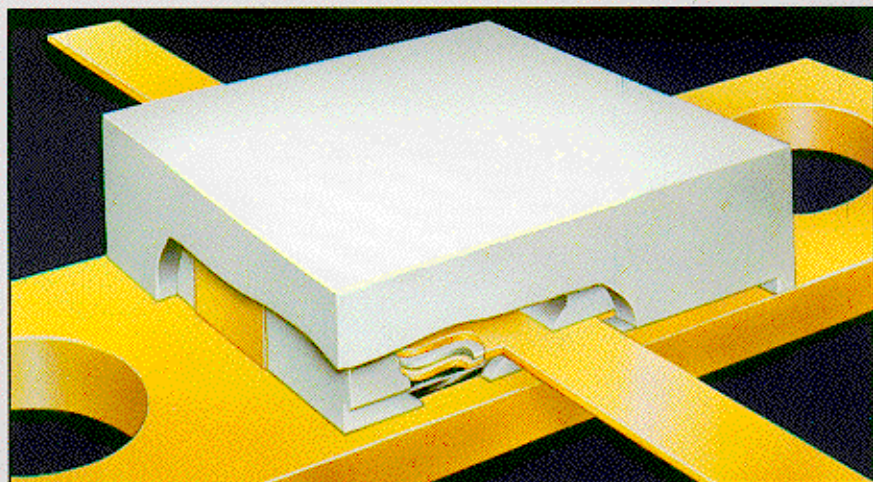
It is this unique chemical composition - made possible only through powder metallurgy - that endows Thermkon® with its high thermal conductivity and low controlled rate of thermal expansion.

What's more, composite powder metals such as Thermkon® allow for intricacy of material design and consistency of parts over large production runs. Often Thermkon® will save you time and money because it is very machinable and often requires less machining due to die design.

Plus, because heat is applied early in the powder metallurgy process, Thermkon® has no memory and will remain flat during later thermal cycling. Annealing is not necessary. Most stamped metal materials are heated later in the fabrication process and have memory ... and thus lose their close tolerances.

Custom plating

CMW will custom plate Thermkon® to meet your precise needs. Our basic plating operation begins with a re-cleaning of the finished but unplated Thermkon® part. Once external impurities have been removed, the



Thermkon® heat sink materials can be fabricated in sizes, thicknesses and shapes to meet the needs of virtually any application. Surfaces are ground to assure flatness within .001 inch per inch of the longest dimension. Custom electroless nickel plating results in a denser, more consistent barrier between the gold overplate and the tungsten-copper or molybdenum-copper base. In these and other ways, CMW takes every care to produce only the highest quality heat sinks.

part is placed in a solution containing nickel. The electroless nickel plate attaches in a consistent and dense manner to the Thermkon® part.

The nickel serves as a barrier and prevents the copper in the base from contaminating the final gold or silver overplate.

Once plating is completed, every Thermkon® heat sink is placed in a furnace at 420 °C for 15 minutes to test its adherence properties and its resistance to blistering and flaking.

Custom gold plated Thermkon® composite materials meet or exceed military specification MIL-G-45204C for purity, thickness, hardness and easy soldering and brazing.

Indeed, CMW's staff of in-plant engineers and researchers have developed a unique cleaning and plating process that clearly meets government specifications.

Quality Assurance

Using American Society for Testing Materials (ASTM) measurement standards, CMW's team of quality assurance engineers test all incoming metal powder material. Material particle size must fall within a narrow micron range. The presence of any concentration of tramp elements in the material - no matter how minute - must result in instant rejection of that lot. Flow characteristics and density of each material must fall within our established guidelines.

To further assure that Thermkon® heat sinks meet or exceed dimensional criteria, dimensions and weights are checked at pressing and after sintering.

We run destructive type sampling tests on random Thermkon® parts to assure microstructural uniformity. Other tests measure conductivity, density and hardness once the fabrication process is complete.

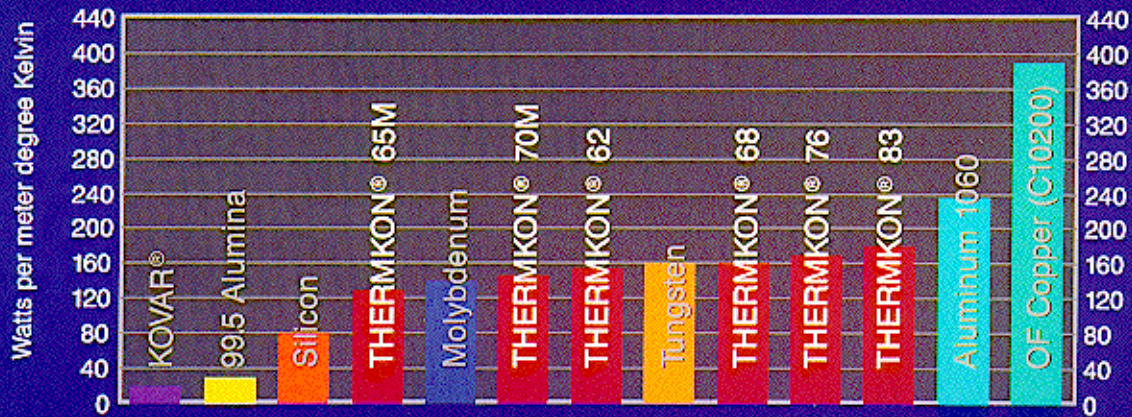
Call or write for more information

Technical and machining data on Thermkon® composite material is in this brochure. For information not contained here, or for application assistance or price information, call or write CMW today. Thermkon®'s high thermal conductivity and controlled coefficient of thermal expansion will put an end to your packaging design trade-offs. Call today.

MIL-G

MIL-G-45204C

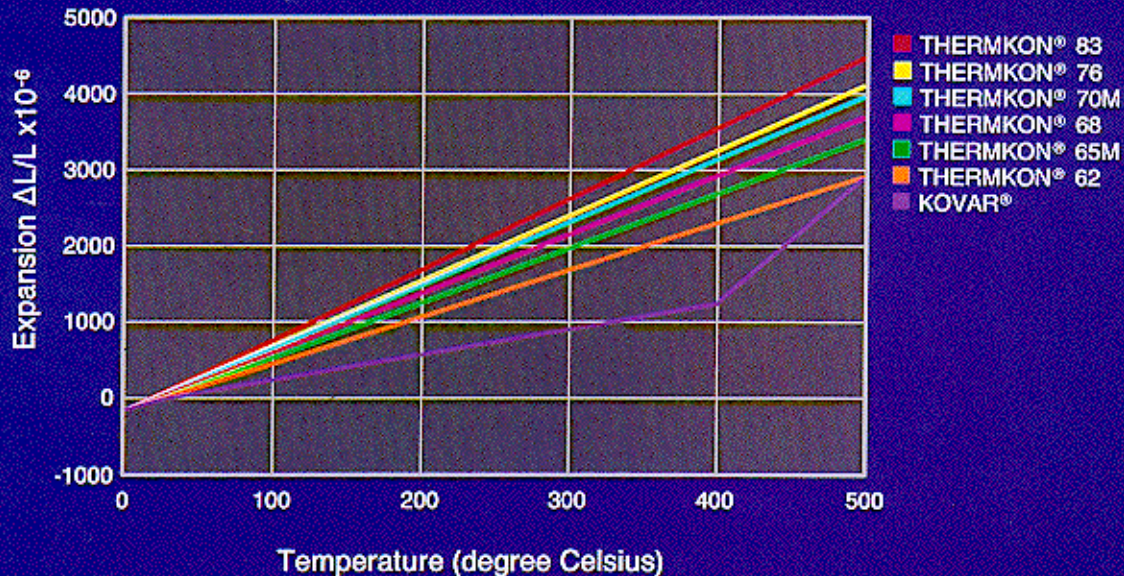
THERMAL CONDUCTIVITY OF VARIOUS METALS AND CERAMICS



Thermal Conductivity at Room Temperature

The Thermal Conductivity of the Thermkon® composite materials ranges from 135 w/m/K to 190 w/m/K. Thermkon®'s thermal conductivity is higher than silicon and significantly higher than the traditional low expansion alloys.

THERMAL EXPANSION FOR VARIOUS HEAT SINK MATERIALS



All Thermkon® materials offer controlled rates of thermal expansion, closely matching those of alumina and beryllium oxide ceramics over a wide range of temperatures. This facilitates joining and reduces detrimental stress in the microelectronics package. These close coefficients may allow the designer to use thinner ceramic substrates in the packaging system.

Technical Data on Thermkon® Composite Materials

TYPICAL PROPERTIES OF CMW THERMKON® MATERIALS

PROPERTY	Thermkon® 83	Thermkon® 76	Thermkon® 68	Thermkon® 62	Thermkon® 70M	Thermkon® 65M
THERMAL CONDUCTIVITY						
BTU/h/°F	110	104	97	91	84	78
w/m/°K	190	180	167	157	145	135
THERMAL EXPANSION						
$\times 10^{-6}$ in./in./°F	4.6	4.2	3.6	3.2	3.6	3.3
$\times 10^{-6}$ m/m/°C	8.3	7.6	6.5	5.7	6.5	6.0
MODULUS OF ELASTICITY						
$\times 10^4$ psi	34	35	36	37	35	36
TENSILE STRENGTH						
$\times 10^3$ psi	100	115	120	125	100	105
YIELD STRENGTH						
$\times 10^3$ psi	76	89	105	116	90	95
FLEXUAL STRENGTH						
$\times 10^3$ psi	150	170	175	180	160	165
ELECTRICAL CONDUCTIVITY						
% IACS	45	41	35	32	32	28
HARDNESS						
	98 HRB	103 HRB	25 HRC	27 HRC	90 HRB	95 HRB
DENSITY						
g/cm ³	14.84	15.56	16.31	17.17	9.85	9.92
lb/in ³	.536	.562	.589	.620	.356	.358
COMPOSITION, WT. %						
TUNGSTEN	75	80	85	90	—	—
COPPER	25	20	15	10	20	15
MOLYBDENUM	—	—	—	—	80	85

MACHINING THERMKON®

Excellent surface finishes on the Thermkon® materials can be produced by milling, shaping, turning, boring, drilling, tapping and grinding techniques. In general, machining Thermkon® materials produces short chips and can be machined without the use of a lubricant or coolant. If a lubricant or coolant is needed, a water soluble lubricant or coolant is advisable. Notches and sharp corners should be avoided where possible. The information contained here should be used as a guide only as each machine shop develops its own practice for machining and grinding.

TOOLS

Tool steel tools can be used, but it is recommended for good machining practice that non-ferrous grade carbide tool material such as C-2 or C-5 be used. For grinding, use crystolon wheels. When grinding tools use a 0° to 5° positive rake, 5° to 7° clearance and a nose radius as generous as possible. Tools need to be sharpened frequently to prevent pulling of material during machining operations.

Turning and Boring

Roughing: Up to .100" deep with .008" feed per revolution for Thermkon® 83 and 76. Up to .050" deep with .008" feed per revolution for Thermkon® 68, 62, 65M and 70M. Finishing: Use .005" to .015" depth of cut with a .002" to .005" feed per revolution for all materials. Use turning speed of 200 sfm for all turning and boring operations.

Milling

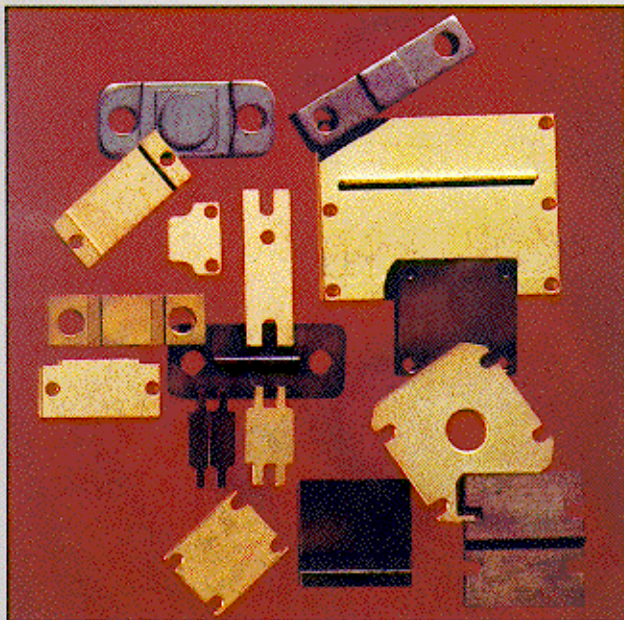
For milling up to .100" depth of cut use a feed of .005" to .006" per tooth with a speed of 80 to 100 surface feet per minute for all materials.

Drilling and Tapping

Use carbide micro-grain drills for best results. Use spiral point taps. Use of coated taps for deep holes will increase tap life. Rigidity is important.

Grinding

Use .0005" to .0015" removal per pass on surface grinding for all materials. It is advisable to use water or a water soluble oil for coolant. Grinding wheels need to be dressed frequently to prevent loading.



Thermkon® composite materials are available in a wide range of custom shapes, sizes and configurations to meet the needs of any application.



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