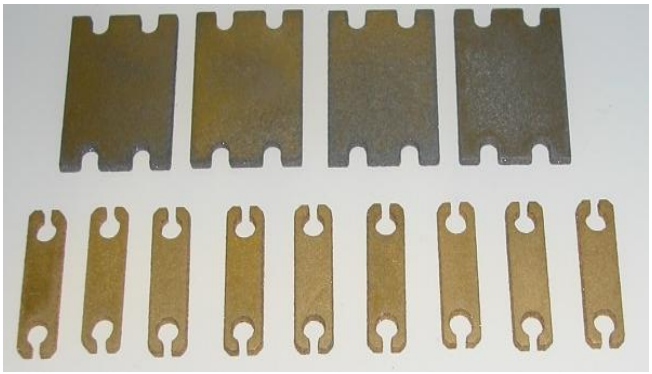
Frequency Asked Questions About NMIC's Aluminum Diamond Products



Q: Aluminum diamond has been in development for many years. What has occurred to make this material commercially viable?

A: NMIC has successfully overcome the challenges required to make aluminum diamond metal matrix composites (MMCs) reliably manufacturable as well as cost-effective. This required extensive work at both the material and processing levels in order to accommodate all of the requirements of the devices to which the material is attached, as well as to reduce the cost to the customer.

Q: What are the advantages that make NMICs aluminum diamond MMC material superior to current solutions?

A: Polycrystalline diamond has the greatest thermal conductivity of any naturally-occurring or synthetic material. When combined with aluminum in composite form, NMIC's aluminum diamond MMCs retain the vast majority of this superior property, while also having a coefficient of thermal expansion near that of silicon carbide (SiC), which is used as a substrate material for high-density compound semiconductor devices such as gallium nitride (GaN) RF power transistors. Together these characteristics (and others) make NMIC's aluminum diamond MMCs far superior to the copper tungsten, copper moly, and copper-moly-copper materials currently employed for heat spreaders.

Q: What specific results have been achieved?

A: In numerous tests as a heat spreader for state-of-the-art GaN RF power transistors, NMIC's aluminum diamond has demonstrated its ability to reduce junction temperature by about 25%. This allows the devices to deliver higher efficiency, higher RF output power, and greater longevity as mean time to failure (MTTF) is reduced with increases in temperature. It also allows the devices to operate at or near their highest potential RF output power levels rather than backing off their RF drive level.

Q: Are there any other applications besides GaN RF transistors in which NMIC's aluminum diamond products can provide similar benefits?

A: Laser diodes employed in both commercial and industrial high-powered lasers generate considerable amounts of heat that must be removed at the device package level. The benefits achievable by aluminum diamond are similar to those that have already been achieved with GaN RF power transistors.

1230 E Speedway Blvd, #211, Tucson, AZ 85721 • 520-300-9272 • fax: 520-300-7095 • info@nanomaterials-intl.com

Frequency Asked Questions About NMIC's Aluminum Diamond Products

Q: What is the range of thicknesses in which NMIC's aluminum diamond material can be made for heat spreader applications?

A: While thickness depends on many factors, an NMIC aluminum diamond heat spreader can be made as thin as 20 mil (0.5 mm) thick while retaining optimum thermal conductivity and stable coefficient of thermal expansion. NMIC aluminum diamond material is isotropic at a thickness greater than 40 mil (1 mm). The variation in thermal conductivity versus thickness results from the aluminum skin layer that that is between 0.05mm (0.002") to 0.10mm (0.004") in thickness. NMIC has standardized the following thickness ranges for our material: 0.020", 0.025", 0.040", and 0.060".

Q: How large can NMIC make aluminum diamond parts?

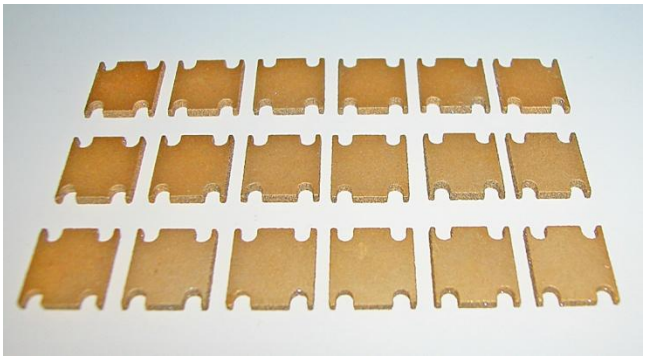
A: The maximum size is 12 x 12 in. (304 mm).

Q: Are there any device profiles that NMIC's aluminum diamond cannot accommodate?

A: The material can accommodate the profile of any RF power transistor or laser diode package style.

Q: How quickly can NMIC deliver parts?

A: The period from when we receive your order to when we can ship our parts depends on their complexity. As a rule, existing designs require 4 to 6 weeks and new designs typically require 6 to 8 weeks.



Q: What brazing options have demonstrated their effectiveness with NMIC aluminum diamond material?

A: NMIC aluminum diamond products can be brazed and provided as Ni/Au plated. Customers routinely die attach to our product (GaN on SiC dies) with AuSn braze and attach ceramic packaging to our material with AuGe.

Q: Does NMIC provide samples of aluminum diamond so that potential customers can conduct their own tests?

A: NMIC can provide 10 x 10 x 1 mm samples or other sizes on request.

Q: How does aluminum diamond compare to copper in heat-critical applications?

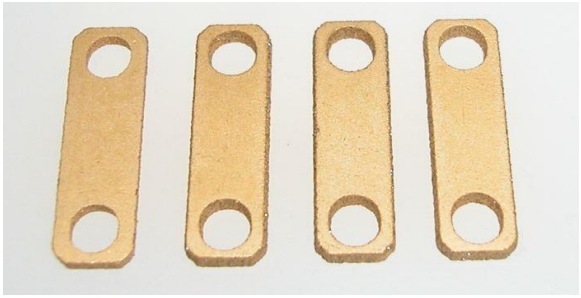
A: As a commodity rather than a composite material, copper is generally not used in the same applications as NMIC's aluminum diamond. Our customers use copper-tungsten, copper-moly, or copper-moly-copper as heat spreader materials. The only exception we have seen is the use of aluminum diamond as a heat spreader for high-power resistors, for which our material is well suited and we have received requests.

1230 E Speedway Blvd, #211, Tucson, AZ 85721 • 520-300-9272 • fax: 520-300-7095 • info@nanomaterials-intl.com

Frequency Asked Questions About NMIC's Aluminum Diamond Products

Q: What is the exact thermal conductivity or range of thermal conductivity of your material?

A: Thermal conductivity is based on thickness. At 60 mil (1.5 mm) thickness, thermal conductivity is greater than 600 W/mK. More information about this subject is available by contacting NMIC by calling (520) 574-1980 ext 137 or sending us an e-mail.



Q: Can vias be fabricated in NMIC aluminum diamond material?

A: Yes. The minimum diameter of a hole that can be placed in the material is 12 mil (0.3 mm).

Still have questions?

Please contact us at (520) 300-9272 or send us an e-mail: info@nanomaterials-intl.com