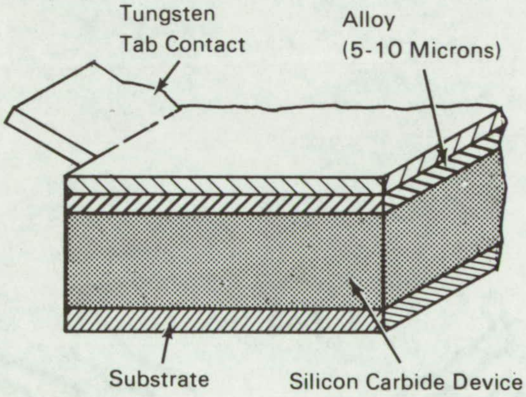
November 1970

Brief 70-10444

NASA TECH BRIEF

Copper–Titanium Eutectic Alloy Improves Electrical and Mechanical Contact to Silicon Carbide

With increased requirements for electronic equipment operating at elevated temperatures, there has been considerable interest in wide bandgap semiconductors such as silicon carbide. The hexagonal (alpha) form of SiC has many desirable qualities. The semiconductor is chemically stable and mechanically rugged and its bandgap of 2.9 eV is more suitable for high temperature operation than silicon (1.2 eV) or gallium arsenide (1.4 eV). However, the chemical stability and hardness of SiC have required excessively high temperature processes to form electrical contacts which have ohmic resistance and are not rectifying. The high temperature causes the contact to penetrate deeply into the material. Also, during cooldown there is a tendency for the contact to shear or break away from the SiC surface because of the differences in thermal expansion coefficients.



Cross Section of Contact Formation on S. C. Device

After considerable research and experimentation, acceptable ohmic contacts were made with the addition of a copper–titanium (Cu-Ti) eutectic alloy between the top metal tab and the SiC surface (see fig.). An alloy composition of 71 atomic % Cu and 29 atomic % Ti (eutectic between the intermetallic compounds $TiCu_2$ and $TiCu_3$) melts at 880°C and readily wets the semiconductor surface. An alloy layer of 5 to 10 microns, applied to the SiC surface, penetrates 300 to 500 angstroms into the SiC material. Tungsten is used as the tab because of similar thermal expansion properties and the ability to resist dissolving in the eutectic alloy.

Contacts formed with Cu-Ti alloy are ohmic on p-type SiC and rectifying on n-type. Current-voltage characteristics of a typical p-n junction device have shown that contact resistance is a few hundred ohms.

Contact preparation at low temperatures is important if metal or oxide films which are susceptible to high temperatures are present in a device structure. In addition, the shallow penetration enables this process to be used for preparing contacts on thin epitaxial films.

Notes:

1. SiC devices, such as diodes, transistors and electroluminescent arrays, will have widespread application in electronics technology when acceptable performance levels and reliability have been achieved.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Headquarters
   National Aeronautics
   and Space Administration
   Washington, D.C. 20546
   Reference: B70-10444

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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(ERC-10256)