

Simple Technique for Making an Electric Contact on Silicon

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ELECTRIC contacts on Si can be made with a variety of materials and techniques. The materials most commonly used are Au, Au-Sb, Au-Ga, In-Ga, Ni, and Al.^{1,2} To improve the contact obtained by simple deposition of the metal an alloy is formed by heating the contact. This in general requires the heating of the whole Si sample: a process not always desirable.

We sought to obtain on high resistivity Si an ohmic contact which did not require the heating of the whole crystal to be studied. As contact material we have used Al for p-type Si and Au-Sb for n-type Si. By sparking on the Si surface with two Al or Au-Sb electrodes, depending on the Si type, we have obtained contacts which have permitted us to work with temperatures as low as that of liquid nitrogen.

For the sparking we used as electrodes a 1-mm-diam wire and a sheet of approximately 0.3-mm thickness, cut in triangular form. As a power source we used ten 36- μ F condensers in parallel charged to a tension that could be adjusted between 100 and 200 V.

Electrode 1 (Fig. 1) is pressed against the Si surface, electrode 2 is approached, gliding it on the sample's surface until the spark jumps. The difference in geometry between the electrodes determines quite well the place where the contact is made, the contact material deposited coming mostly from the triangular electrode. To increase the contact area this process can be repeated several times. It is convenient to abrade the Si surface before making the contacts. No appreciable difference is found when the contacts

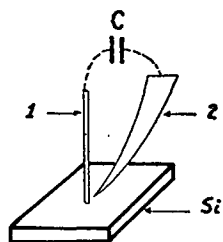


FIG. 1. Electrode arrangement for making the "sparked contacts."

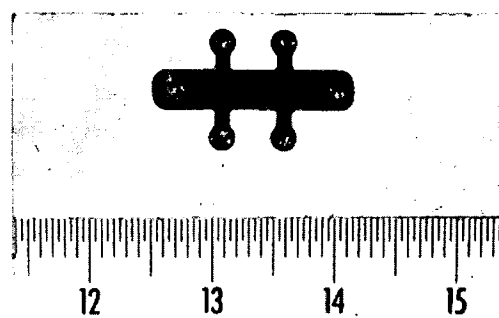


FIG. 2. Si n sample showing the sparked Au-Sb contacts (scale in cm).

are made in an argon atmosphere or in air. In Fig. 2 is shown an n-type Si sample with Au-Sb contacts made using the procedure here described.

For a p-type Si of 7500 Ω -cm we have measured the following contact resistances as function of the temperature: for 15°, 1.8 k Ω /cm²; -60°, 3 k Ω /cm²; and -120°, 3.6 k Ω /cm²; for an n-type Si of 900 Ω -cm we had the following contact resistance values: for 15°, 0.15 k Ω /cm²; -147°, 0.23 k Ω /cm²; -170°, 0.90 k Ω /cm²; and -190°, 1.45 k Ω /cm² (contact area for both cases is approximately 1 mm²). Since the augmentation of the contact resistance is not an irreversible process we can say that there exists no appreciable cracking at the contact due to differences in thermal expansion.

In general the sparked contacts are highly reliable, presenting at the same time the advantage of the simple equipment needed and the time, which is very short if compared with that needed for a vacuum or electrolytic bath metalization.

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¹ *Transistor Technology* (D. Van Nostrand Company, Inc., Princeton, New Jersey, 1959), Vol. 1, edited by H. E. Bridgers, J. H. Scaff, and J. N. Shive, and Vol. 2, edited by F. J. Biondi.

² S. Sullivan and J. H. Eigler, *J. Elec. Soc.* 104, 226 (1957); H. M. Mann and F. J. Janarek, *Rev. Sci. Instr.* 33, 557 (1962); E. Matsura, K. Matsui, and R. R. Hasiguti, *J. Appl. Phys.* 33, 1610 (1962).