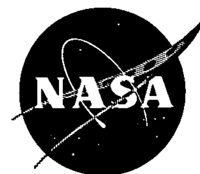
View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

NASA TECH BRIEF

Marshall Space Flight Center



NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

Silicon Contact for Area Reduction of Integrated Circuits

The problem:

In the design of integrated circuits, the contacts are normally made smaller in area than the diffused semiconductor in order to minimize the possibility of contact between the metal and those areas whose

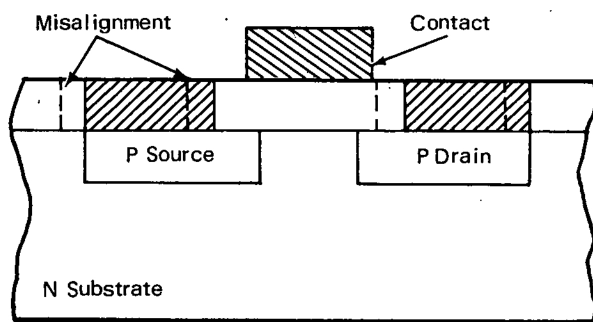


Figure 1. Doped Silicon Contact Does Not Cause Shorts Due to Misalignment.

conductivity type is opposite that of the diffused semiconductor. Such contact could occur during misalignment. Aluminum is universally used as the interconnecting metal, and the aluminum work function is comparable to that of silicon. An alloyed aluminum contact, then, makes good ohmic connection with P-type silicon; but a leaky reverse junction occurs with the N-type silicon. For N-channel MOS transistors, the alloyed aluminum will cause a short circuit if it comes in contact with the P-type substrate. Because the reduction in contact area is not completely effective, undesirable metal contact can still occur.

The solution:

A semiconductor (e.g., doped silicon) contact is used in place of the metal contact (see Fig. 1). The semiconductor contact forms a low leakage junction with the background material even if misalignment occurs.

How it's done:

The schematic of Fig. 2 shows a metal oxide semiconductor (MOS) transistor in which the

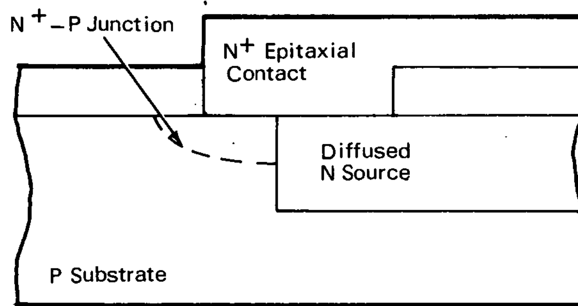


Figure 2. Epitaxial Growth Increases Radius of Curvature of Diffused Front.

contact windows are opened through the oxide after diffusion steps are completed. (The windows may be the same size as the diffused area.) Silicon, doped in the same conductivity type as that of the diffused area, is epitaxially deposited through the windows. For MOS integrated circuits, the N-doped silicon contact is ohmic to the N-type diffused source and drain (not shown), but is rectifying to the P-type background (substrate). The rectifying junction between the N^+ contact and the reverse-biased P-type background results in very low leakage current. The leakage current can be further minimized by increasing the radius of curvature of the N^+-P junction at the edge of the N^+ contact (dashed line). If the silicon contact is grown epitaxially at high temperature (1523 K), diffusion will occur, and the radius of curvature will be increased.

(continued overleaf)

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Code A&TS-TU
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: TSP71-10368

Patent status:

No patent action is contemplated by NASA.

Source: H. C. Lin of
Westinghouse Electric Corp.
under contract to
Marshall Space Flight Center
(MFS-20688)