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NASA TECH BRIEF

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Technique for Producing Bipolar and MOS Field Effect Transistors on a Single Chip

A method has been described for the simultaneous production on a single, monolithic silicon chip of vertical npn transistors, lateral pnp transistors, and p-channel, enhancement mode MOSFET devices.

Initially, two epitaxial layers are grown on a p-type silicon substrate. The first, p-type, is heavily doped with arsenic, and the second, n-type, is heavily doped with phosphorus. After the surface layer is oxidized, several cycles follow of photoetching, dopant deposition, and drive-in, to produce selectively-doped regions and semiconductor junctions within the chip. In the first cycle, the areas exposed by photoetching are heavily doped with boron. These p-type regions, together with the p-type, arsenic doped epitaxial substrate, form channels which isolate each device from its neighbors. Second, the base region of the npn transistor is doped with boron and driven in deeply, to leave space for the emitter. Third, the emitter and collector of the lateral pnp transistor, and the source and drain of the MOSFET are doped with boron. Fourth, the npn emitter and the pnp base are doped with phosphorus.

Next, the gate region of the FET is exposed, the device is thoroughly cleaned, and the gate dielectric is oxidized. The dielectric is then doped with phosphorus, which at the same time forms a phosphorus glass passivation layer over the entire chip.

Immediately following the doping of the dielectric, a layer of aluminum is deposited over the entire chip by electron beam evaporation. This layer prevents shorts-through the dielectric and protects it from contamination.

Contact windows are etched through the aluminum and through the underlying oxide, and a second layer of aluminum is deposited, filling the contact windows. Subsequently, a final etching separates the contact regions and forms the bonding pads and interconnections. After sintering to form ohmic contacts, the wafers are ready for final evaluation, scribe and dice, and packaging.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Manned Spacecraft Center, Code BM7
Houston, Texas 77058
Reference: B70-10218

Patent status:

No patent action is contemplated by NASA.

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Category 01

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