Position control of a transistor source–drain junction with sub-nanometer accuracy

Expected to be a new junction technology for the MOS transistors of 16-nm generation and beyond

We have developed a new metal source-drain junction technology that can be applied to the transistors of 16-nm generation and beyond. In the very small metal-oxide-semiconductor (MOS) transistors of 16-nm generation and beyond, the parasitic resistance of the source-drain junction will become a big issue because it would ruin the improvement of the transistor performance. In addition, it is a big challenge to fabricate a source-drain junction accurately in transistors with a gate length in the order of 10 nm. The developed technology allows us to control the position of a very low-resistive metal source-drain junction at the sub-nanometer level. The control technology has been demonstrated to increase transistor performance significantly and should provide a solution to junction position control in the MOS transistors of 16-nm generation and beyond.

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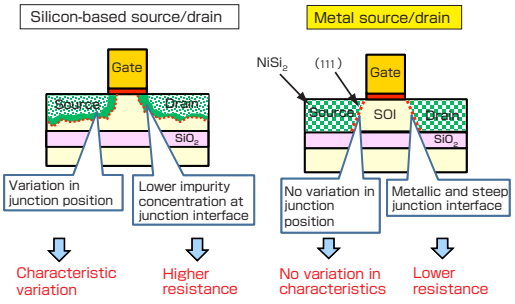
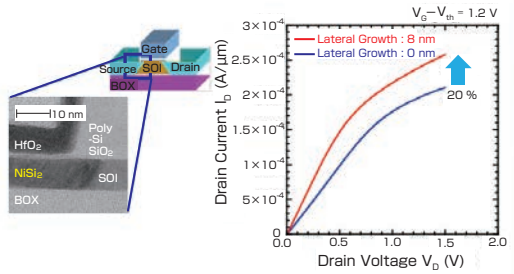


Comparison between the silicon-based source–drain junction and the metal source–drain junction



A thin SOI MOS transistor with the metal source–drain junction fabricated by using the developed technology, and its properties

Development of silicon nitride ceramic with high thermal conductivity

Expected as circuit boards for power devices

Applications of semiconductor power modules are rapidly expanding in a broad range of fields such as power generation systems and electric transportation systems. With increasing power supply and packing density of power devices, the ceramic boards are required to have high strength and high toughness as well as high thermal conductivity. Silicon nitride is an attractive candidate material because of its excellent mechanical properties combined with high intrinsic thermal conductivity over 200 $Wm^{-1}K^{-1}$. However, thermal conductivities of silicon nitride materials fabricated via the conventional sintering method are insufficient. This is because impurity oxygen dissolved in Si_3N_4 grains causes phonon scattering to lower their thermal conductivities. In order to decrease dissolved oxygen, high purity silicon powder was employed as a starting raw material. We have succeeded in preparing Si_3N_4 with a very high thermal conductivity of 177 $Wm^{-1}K^{-1}$ and good mechanical properties by nitriding a silicon powder compact followed by post-sintering.

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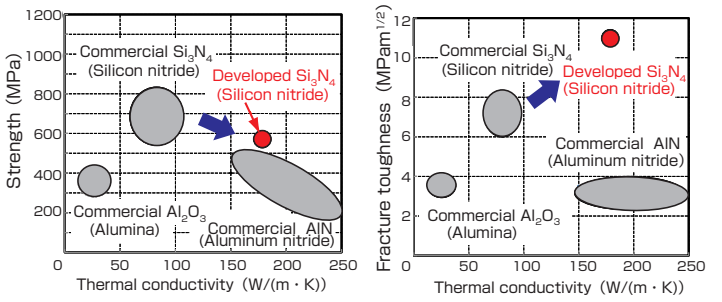

(a) Relation between strength and thermal conductivity

(b) Relation between fracture toughness and thermal conductivity

Mechanical and thermal properties of commercial ceramic boards and the developed silicon nitride board