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Application of Si-Wafer Direct Bonding to High-Temperature Integrated Pressure Sensors

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The influence of built-in stress on the electrical and piezoresistive properties of Si-on-insulator (SOI) films prepared by Si-wafer direct bonding (SDB) technique has been investigated. The characteristics of MOS transistors fabricated on thick (8500 Å) SOI films were very similar to those of bulk Si, but inferior to those on thin (2500 Å) SOI films. A gauge factor and the temperature coefficient of the gauge factor at a boron doping concentration of between 3×10^{18} and 1×10^{20} cm^{-3} were the same as those of bulk Si. Using SiO_2 films as a dielectrical isolation (DI) layer, we have fabricated piezoresistive pressure sensors on the SOI structure. The implemented sensors have a high sensitivity of 0.039 mV/V·mmHg for a 700-mmHg full-scale pressure range, with a nonlinearity and hysteresis of less than +0.18%FS and +0.05%FS, respectively. In the temperature range of from −20°C to +350°C, the shifts in sensitivity and offset voltage were less than −0.2% and +0.15%, respectively. From these results, devices using the SOI structure presented here are very suitable for high-temperature integrated pressure sensors.

1. Introduction

In the past decade, SOI (Si-on-insulator) structures have been investigated for device applications such as 3-dimensional integrated circuits, power and new thin-