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Thermal Conductivity of Porous Silicon

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The thermal conductivities of porous silicon and oxidized porous silicon are measured. Nanoporous silicon has a thermal conductivity less than 2 W/mK. Therefore it is a good material for thermal isolation.

1. Introduction

Presently porous silicon is being intensively investigated due to its luminescence properties. However, there are many other possible applications in sensor technology and microstructuring where porous silicon has interesting applications. One of them is the use for thermal structures. Many thermal sensors are based on the measurement of small amounts of thermal energy. An example is the detection of infrared radiation with a thermocouple. A small amount of heat must cause a large temperature variation of the thermal structure. Therefore, the heated body must be small and well isolated from its support, which normally is a silicon chip. Another application for thermally isolated microstructures are heated structures for sensors, *e.g.*, gas sensors, which require a heated sensitive layer. In these cases the structure must be isolated in order to conserve electrical energy during the heating of the system and in order not to heat up the entire chip so much as to cause a drift of the signals.

Figure 1 shows three methods to realize a thermally isolated structure by means of silicon micromachining. Silicon itself cannot be used for the support of the structures because of its high thermal conductivity ($\approx$ 150 W/mK). Usually a membrane is made from a thin isolating film, as shown in the common structure of thermal sensors for infrared radiation (*e.g.*, thermocouple, bolometer) presented in Fig. 1(a). For the membrane, the use of silicon oxide, silicon nitride[1] and silicon carbide[2] is described in literature. Generally the membrane is structured by anisotropic etching of the wafer in KOH solution. A second