Gold-Silicon Eutectic Wafer Bonding Technology for Vacuum Packaging

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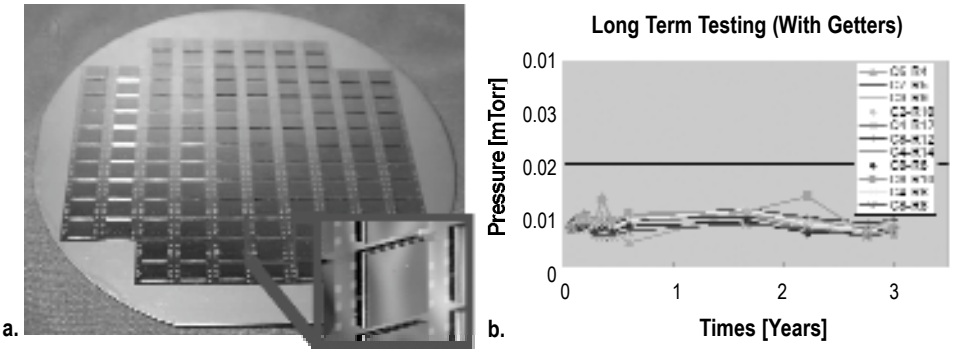

(a) Wafer-level packages, and (b) long-term reliability data showing vacuum pressures that have held over more than 600 days of testing.

Low-cost, simple, reproducible hermetic/vacuum packaging technologies are required for many microsystems. Several wafer bonding techniques, including adhesive, glass frit, solder, eutectic, silicon fusion/direct and anodic bonding have been used in the past. Of these, eutectic bonding is attractive because it is easy to use, forms a soft eutectic allowing bonding over nonplanar surfaces, and can be done at the eutectic temperature (363°C). Using this technique, a cap wafer is first made by electroplating 4m gold on a patterned Cr/Au seed layer using KOH wet etching to obtain 90m deep cavities. This wafer is then bonded to a device wafer at 10Torr, 390°C, and roughly 100kPa of pressure through a controlled sequence to achieve uniform bonding. Pirani (vacuum) gauges were specially designed to measure package pressure. The picture on the left shows a wafer with 124 encapsulated vacuum sensors. Encapsulating devices with Nanogetters,[1] pressures ranging from 1mTorr to 16mTorr with only small variation were achieved after nearly three years of testing as shown in the figure on the right. Furthermore, in reliability testing, package pressures stayed within ±1mTorr even after 100 hours at 150°C, thermal cycling and vibration, shock, and soak tests. This project is supported primarily by the Engineering Research Centers Program of the National Science Foundation under award number EEC-9986866.

[1]A proprietary product provided courtesy of Integrated Sensing Systems (ISYSS) Corporation, 391 Airport Industrial Drive, Ypsilanti, Michigan 48198.