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Smart Interposer Technology for Electrically Reconfigurable Operation

Background

Interposers are now used extensively in the semiconductor industry to provide connections between silicon integrated circuits (ICs) and certain types of package, and to provide connections between multiple ICs within the same package to create a system-in-package (SiP) design. Advanced interposers not only contain multiple layers of wiring but can also have integrated passive devices (IPDs) such as resistors, capacitors, or inductors, and through-silicon vias (TSVs) which are electrical connections through the interposer that allow ICs to be placed and interconnected on both sides of the substrate. To lower manufacturing cost, many interposers are manufactured with standard elements, such as arrays of TSVs, which are used with wiring schemes that are specific to a particular system design. A system built on the interposer can therefore comprise standard or custom ICs (or a combination of both) but be endowed with custom functionality by the way in which the interposer connects the IC components to each other, to the power grid, and to passive components on the interposer. However, conventional interposers are customizable only at the fabrication stage.

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Invention Description

Research at Arizona State University has led to the development of a smart interposer (SI) featuring programmable metallization cell (PMC) switches fabricated on the interposer, allowing the interposer to be configured electrically after fabrication and even after the completion of SiP assembly.

The most suitable PMC switches may be based on a copper-silicon oxide material system (Cu-SiO_x, where $x < 2$), as described in US Patent Number 7,372,065. The major advantages of this material system are: (1) sharing of copper-based metallization used in interposers; (2) compatibility with existing tools and processes used in interposer fabrication; (3) low temperature (<200 °C) deposition so that various interposer materials can be used, including organic substrates; (4) low voltage/low current operation so that existing power rails can be used without charge pumps; and (5) a highly stable on state which can be used to control signal and power routing.

Potential Applications

- Integrated circuit (IC) design
- Secure system fabrication
- Internet-of-Things (IoT) devices

Benefits and Advantages

- Customization – Allows customization of functionality (even in the same chip set) by configuring the routing of data/address busses, enables/hard interrupts, power lines, and IPDs.
- Field Configurability – Can be programmed or reprogrammed at any time including at the final test of the SiP or by the end user in the field. This enables the customer to adapt functionality to a particular use circumstance or to provide just-in-time updates.
- Functional Obfuscation – Provides IC design security in non-trusted fabrication environments by conferring true functionality at the post-fabrication stage during SI programming.

[Faculty Homepage of Professor Michael Kozicki](#)