MANUFACTURING OPTICALLY ACCESSIBLE CO-PACKAGED OPTICS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Non-Provisional Patent Application No. 18/660,824, entitled "MANUFACTURING OPTICALLY ACCESSIBLE CO-PACKAGED OPTICS", filed on May 10, 2024, which claims priority to Provisional Patent Application No. 63/579,486, entitled "OPTICALLY ACCESSIBLE PHOTONIC BRIDGE PACKAGE", filed on August 29, 2023, the entirety of which is incorporated herein by reference.

BACKGROUND OF THE DISCLOSURE

Co-packaged optics refers to the integration of optical components directly with electrical integrated circuits (EICs), such as processing units and other application specific integrated circuits (ASICs), to provide packages that use a combination of electrical and optical signals to communicate and process data. In many designs, a photonic integrated circuit (PIC) is used to communicate optical data within a package and optical fibers are commonly used to relay optical data between packages. An optical interface, e.g., for receiving a pluggable module, is used to facilitate connecting an end of an optical fiber to a package. Such interfaces can couple light from the fiber into a waveguide in a PIC via a port on the surface of the PIC of at an edge of the PIC. In either case, arrangement of components in a package should provide ample access to the PIC to accommodate the optical interface for robust and reliable attachment of the optical fiber(s).

SUMMARY

A first aspect of the present disclosure provides an integrated circuit package which includes a first electrical integrated circuit (EIC), a photonic integrated circuit (PIC) comprising an active element, an optical coupling element at a surface of the PIC, and one or more waveguides, the first EIC being attached to the surface of the PIC overlapping a portion of the PIC, the active element being located in the portion of the PIC overlapped by the first EIC, the active element being electrically connected to the first EIC, and the

optical coupling element being in another portion of the PIC not overlapped by the first EIC, and a spacer protruding from the surface of the PIC in the other portion of the PIC not overlapped by the first EIC, the spacer being transparent for light in an operative wavelength band of the PIC, wherein the transparent spacer is positioned over the optical coupling element, and the transparent spacer, optical coupling element, and one or more waveguides provide a first optical path through the package to the active element for light in the operative wavelength band.

A second aspect of the present disclosure provides a method for manufacturing an integrated circuit (IC) package which includes providing a base assembly comprising a photonic integrated circuit (PIC), the PIC comprising an active element, a coupling element at a surface of the PIC, and one or more waveguides providing an optical path through the PIC between the optical coupling element and the active element for light in an operative wavelength band of the PIC, attaching a first spacer to a surface of the base assembly over a first portion of the PIC including the optical coupling element, the spacer being transparent for light in the operative wavelength band, attaching a first electrical IC (EIC) to the surface of the base assembly overlapping a second portion of the PIC away from the optical coupling element, depositing a first molding compound over the first spacer and the first EIC to form a layer of the first molding compound encapsulating the first EIC and the first spacer, and removing a first portion of the first molding compound from the layer of the first molding compound to expose a surface of the first spacer opposite the PIC.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of an example system that includes a circuit package with co-packaged optics.

FIG. 2 is a schematic cross-sectional view of another example system that includes a circuit package with co-packaged optics.

FIG. 3A is a schematic plan view of an example of a circuit package with co-packaged optics.