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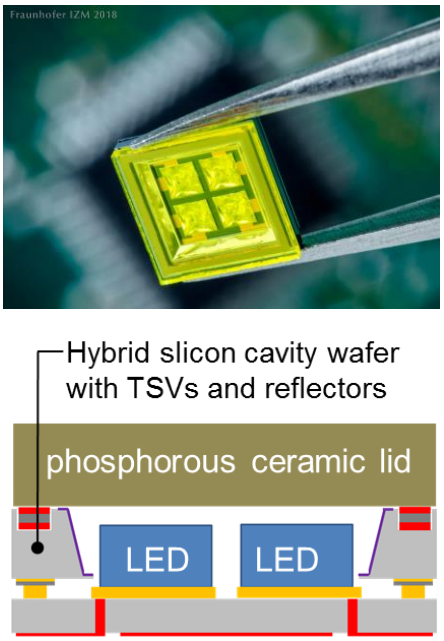


Image of Hermetic Wafer Level Package with 4 LEDs (top), schematic cross section of package structure (bottom)

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# Hermetic WLP of LEDs for White Light Applications

Light emitting diodes (LEDs) are continuously increasing their market share for conventional indoor lightning applications. These white light emitting devices typically use blue light emitting diodes which transmit their radiation through a yellow phosphorescent powder fixed in a polymer matrix to obtain a wavelength mix and a final conversion into white light. The polymer is in direct contact with the LEDs causing several disadvantages in terms of thermal management / heat removal, chemical robustness and long term stability of such devices. A better approach is the use of inorganic ceramics as light converter which are chemically stable over the lifetime of the device. Devices with ceramic converters are becoming more and more common, but the converters are still directly attached to the LEDs by polymer, which still limits the robustness of such components.

Fraunhofer IZM has developed a new hermetic wafer level packaging approach for fabrication of white light LEDs with suspended phosphor ceramic converter. In this new architecture, the ceramic converter is not directly attached to the LED chip but part of the package and is arranged with a defined distance to the LED. This enables the heat generated by the light conversion to be dissipated directly via the ceramic converter into the package instead of through the LED itself. The packaging approach relies on through silicon via (TSV) based silicon interposer wafers which are wafer to wafer bonded to silicon frame wafers using AuSn seal rings to form cavity wafers. The frame wafers have through cavities with sloped mirroring side walls to enable an optimal reflection of light out of the cavities and thus a high efficiency of the mounted LEDs.
The LEDs are bonded into the cavities onto the silicon interposer which feeds the electrical contacts to its back side. The cavities with the mounted LEDs are subsequently sealed with the phosphor converter ceramics. The created LED modules are subsequently assembled to test boards. The process was proven until demonstration level. The fabrication of the TSV interposer wafers and frame wafers as well as the wafer bonding was done at 200 mm format. LED assembly to the cavity wafer as well as the final sealing with the ceramic lids was done at chip level.

Beyond the demonstrated LED packaging Fraunhofer IZM offers a broad spectrum of fabrication and sealing technologies for cap or cavity wafers which are applicable for diverse custom specific hermetic wafer level packaging approaches.