Ultra Thin Flexible Microelectonics

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Researchers at the Johns Hopkins University Applied Physics Laboratory (APL) have developed advanced processes to produce thin, flexible microelectronic assemblies that are 100-μm (0.004-inch) thick, only slightly thicker than the diameter of a human hair. These processes are highly reliable, high-yielding, and highly manufacturable. Relying on established expertise and using new, innovative techniques, APL researchers have recently advanced their ability to develop these thin, flexible microelectronic assemblies to a new limit—APL researchers can now produce these ultra-thin, flexible microelectronics assemblies with thicknesses of only 30-mm.

APL's processes yield low-cost, highly manufacturable flip-chip assemblies. This new capability for assembling thinned die to polyimide flex substrates achieves low ultimate system height between the chip and the substrate or interposer, thereby producing paper-thin microelectronic assemblies that are close to their theoretical limit of minimum thickness and have a higher interconnect density than commercially available components. APL's processes have been thoroughly qualified through stringent reliability testing; yield components that significantly surpass the current reliability standards required of commercial components; and eliminate the need for special handling, tools, and techniques.

APL's ultra-thin microelectronic assemblies offer advantages in their ruggedness; lightweight and compact size; and low power consumption. In addition, the assemblies are conformable, such that they may be mounted or laminated to curved surfaces and serve in applications requiring assemblies of a non-standard form factor.

The exciting array of potential uses of APL's microelectronic assemblies includes smart cards; active circuit appliqués; highly miniaturized and implantable biomedical devices; incorporation of active circuitry into fabric (i.e. 'smart' fabrics); and application of active circuitry onto fixed-curved surfaces.

APL's researchers have also envisioned the use of these microelectronic assemblies for the fabrication of high-density applications and very thin 3-D modules. Specifically, qualified, preassembled thin flex-circuit layers may be stacked and laminated together, followed by the processing of vertical interconnections.

Paper-thin assemblies were demonstrated and qualified by assembling thinned, bumped silicon die onto commercial flex wiring substrates. This process results in assembly yields in excess of 98% and is highly manufacturable because it uses traditional surface-mount flip-chip techniques and equipment. No specialized tools are required for this process.

The potential commercial impact will be significant, reducing manufacturing costs and enabling new products.