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Compliant, heterogeneously integrated micro-VCSELs

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ABSTRACT

Vertical cavity surface emitting lasers (VCSELs) represent a ubiquitous light source with unique performance characteristics that excel edge-emitting lasers or light-emitting diodes. VCSELs are available, however, mostly on growth wafers in rigid, planar formats over restricted areas, thereby frustrating their use for applications that benefit greatly from unconventional design options including large-scale, programmable assemblies on unusual substrates, hybrid integration with dissimilar materials and devices, or mechanically compliant constructions. Here the author will present our recent efforts on materials design and fabrication strategies that overcome limitations of conventional VCSELs and create new application opportunities that are unavailable in existing technologies. Specialized epitaxial design and fabrication processes, together with printing-based integration methods, enable defect-free release of ultrathin, microscale VCSELs and their device-level implementation on non-native substrates in scalable, cost-effective fashions. Demonstrations in large-scale, addressable arrays of VCSELs on plastics for flexible near-infrared laser displays, and heterogeneous assemblies with silicon-based electronics to form integrated optoelectronic sensors illustrate unique capabilities.