# Manufacturing Strategies for Flexible and Stretchable System in Package

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## Abstract

Manufacture of the next generation of wearable electronic devices and flexible electronics demand ultrathin silicon wafers.1,2 For example, the currently available IC (integrated circuit) chips used in wearable electronic system are built on silicon wafers of thickness less than 100μm. And the inorganic chips used in flexible electronic system3 should be thinned to micro-membranes of thickness about 15μm to improve the mechanical flexibility of devices to adapt to arbitrary curved objects4. Commercially available wafers have thickness of several hundreds of micrometers, so the wafers thus need to be thinned for new applications. Diamond grinding has been recognized as an irreplaceable thinning technique to obtain thinned wafers with good performance for applications in optics, electronics, bio-technology, medicine and flexible electronics. Studies on micro-diamond grinding technique, diamond wheels, and machine tools in silicon grinding process have been extensively reported. However, few articles have reported physical nano-diamond grinding process without any chemistry in silicon grinding technique.
In this paper, we report a strategy to thin silicon wafers and devices used for integrated circuit system (i.e. wearable electronics) and flexible electronics. The grinding technology only uses nano-diamond particles without any chemistry, which is different from previous strategy (i.e. Chemical Mechanical Polishing) and protects chips from chemical corrosion. Then we demonstrate the intrinsic mechanism of nano-diamond grinding to nano-cut and penetrate the substrate surface to obtain ultrathin devices. We also experimentally investigate the behavior of ultra-thin and flexible devices after nano-diamond grinding and compare it to the behavior of devices before-grinding. Finally, we integrate ultra-thin devices onto flexible substrate and package devices in the system.

## References

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