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Demonstration of the diamond thin film transfer SmartCut™ technology on a silicon wafer

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Thin film transfer techniques are key for the development of many applications in the semiconductor industry. In particular, the SmartCut™¹ technology is being increasingly used on Silicon, to design well-controlled thin film stacks to push devices performances further. On diamond, in addition to the development of innovative ultra-wide-band-gap devices, the SmartCut™ could address specific challenges related to the small substrate size available. For example, the fabrication of large high quality diamond tiled substrates. As well as the simplified and more efficient device fabrication in standard clean room facilities, thanks to a standard size handling substrate.

In a previous work², we proposed the SmartCut™ process on diamond described in Fig.1 a-d. First, a buried damaged layer is formed by ion implantation a few hundred nanometre deep below the surface of a diamond plate. Then, the diamond is bonded to a receiver substrate, typically a silicon wafer. A final annealing causes the propagation of a fracture inside the damaged layer, allowing the separation of the film from the diamond substrate. Suitable experimental implantation and annealing conditions were reported and optimized^{3,4}, but no transfer could be achieved.

In this work, we demonstrate for the first time the partial transfer of a 1.8 mm² and 800 nm thick (100) diamond layer on a silicon wafer (Fig.1 c-d). Prior to wafer bonding, Ti was deposited on the diamond and the silicon front faces before contacting them. We will show SIMS, AFM, Raman and XPS characterizations to explain the physical mechanism behind the damaged implanted layer fracture. Moreover, we will discuss key issues and perspectives of the diamond SmartCut™

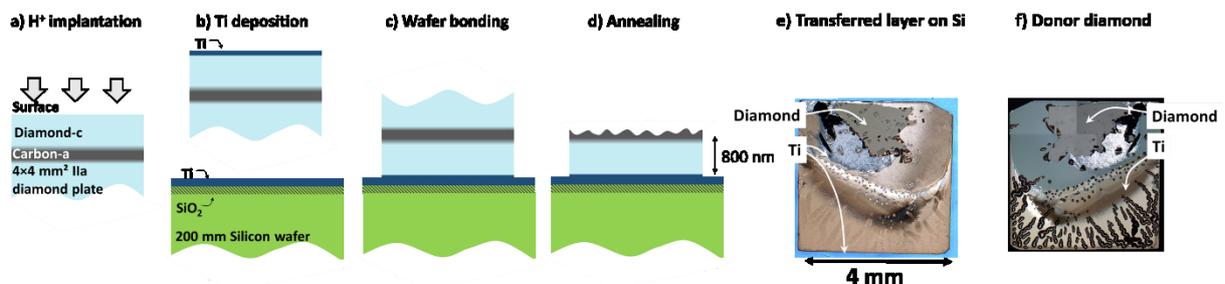


Figure 1 – Diamond SmartCut™ process demonstrated in this work. a) Proton implantation to create a damaged buried layer, b) Ti deposition prior to wafer bonding, c) bonding of the diamond on a silicon wafer, d) annealing to fracture the damaged layer. e) Optical top view of the transferred layer after annealing and f) of the donor diamond.

technology for future industrial applications.

References

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