Cost-effective layer transfer by Controlled Spalling Technology

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There are numerous methods available for removing thin surface layers of one substrate and transferring them to another substrate. Some of the more successful methods such as Smart-cut [1], Eltran [2], epitaxial layer lift-off (ELO) [3] and their variants share the common trait that expensive equipment is required to perform layer removal. Moreover, these techniques tend to be useful on some material systems, and not on others. Lastly, all of these techniques expose the substrate to harsh conditions such as ion bombardment, high-temperature, or aggressive chemicals limiting their applicability to partially or completely finished devices.

What we present here is a simple, cost-effective process for removing surface layers from essentially any brittle substrate at room-temperature, and with inexpensive laboratory equipment. The process, called controlled spalling technology [4], can be applied at nearly any point during device fabrication from starting substrates to completed devices. The process works by exploiting a curious mode of brittle fracture, and mechanically guiding a fracture front across a wafer surface.

We will present an overview of the controlled spalling process and then demonstrate a number of applications to illustrate the versatility of this new approach to layer transfer. We have applied this process to thin-film Si and III-V photovoltaic (PV) technologies [4,5] (Fig. 1), kerf-free ingot slicing (Fig. 2), and GaN-based materials (Fig. 3). We will show that controlled spalling technology provides a cost-effective and simple approach to layer transfer of a wide range of materials and is independent of substrate size or dimensions.

FIG. 1. From left to right: a 20 μm thick Si layer on plastic (in a support frame), a flexible 8 μm thick III-V multi-junction layer on a cylinder and a bulk Si layer from which the surface layer was removed.

FIG. 2. Layer transfer of GaAs directly from a 2” ingot onto polyimide tape.

FIG. 3. Cross-section SEM image of controlled spalling of GaN from a sapphire wafer.

References: