Epitaxial Lift-Off of Large-Area GaAs Thin-Film Multijunction Solar Cells

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Epitaxial lift-off (ELO) is a processing technique which enables thin epixaxial layers grown on GaAs or InP substrates to be "peeled off" from the original host substrate. Although explored by many groups since the 1970s, ELO is finally transitioning into a viable manufacturing technology. The ELO process offers several important advantages for both performance enhancement and cost reduction of III-V electronic and optoelectronic devices. The epitaxial films can be transferred to new support substrates that are thin, flexible, lightweight, and with higher thermal conductivity than the original growth substrate. The GaAs or InP growth substrate can be reused many times. At MicroLink Devices we have developed an ELO process capable of lifting off large areas of semiconductor material (up to 6-inch diameter) without any degradation of the epilayer quality or performance characteristics. We are actively pursuing the commercialization of this technology for fabricating thin, flexible large-area multijunction solar cells with very high efficiency. Potential applications include electric-powered, unmanned aerial vehicles (UAVs), space satellites, as well as terrestrial solar concentrator systems.

In this presentation we will provide an overview of the current ELO process technology for both GaAs and InP materials and present recent device results on large-area ELO triple-junction inverted metamorphic (IMM) solar cells and solar arrays. We will also discuss the application of the ELO process to other III-V devices such as HBT transistors and photodetectors. Finally, we will present our work on GaAs substrate repolishing and the feasibility of multiple substrate reuses after ELO.

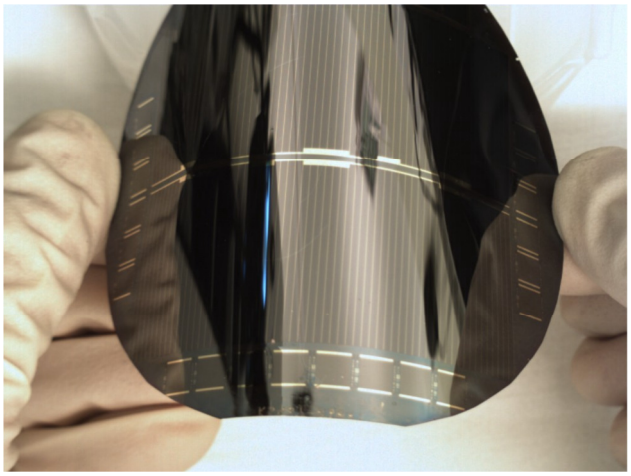

Fig. 1 4-inch GaAs ELO foil attached to a thin and flexible metal backing. The wafer contains two large-area (20-cm^2) multijunction solar cells.

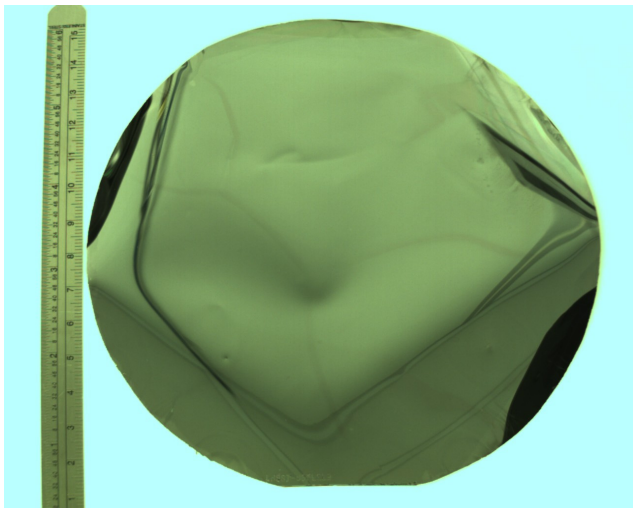

Fig. 2 Six-inch GaAs ELO foil

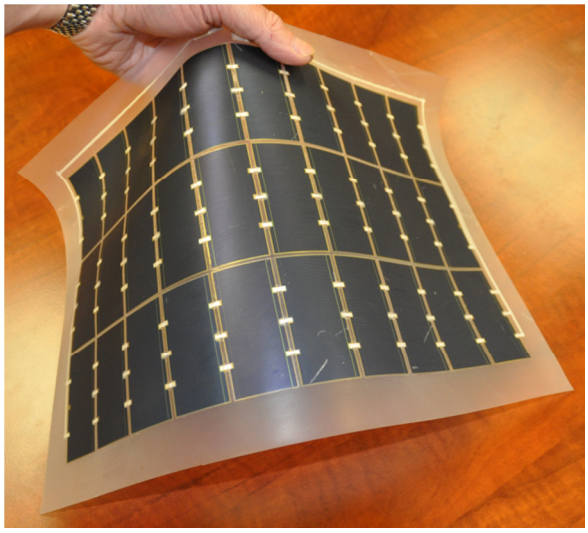

Fig. 3 Flexible solar sheet consisting of an array of 30 interconnected, large-area GaAs solar cells

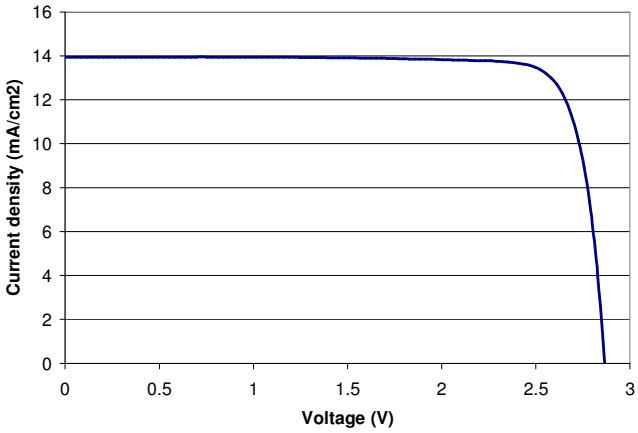

Fig. 4 I-V characteristic of a triple-junction inverted metamorphic (IMM) ELO solar cell with an AM1.5 one-sun efficiency of 33.5%.

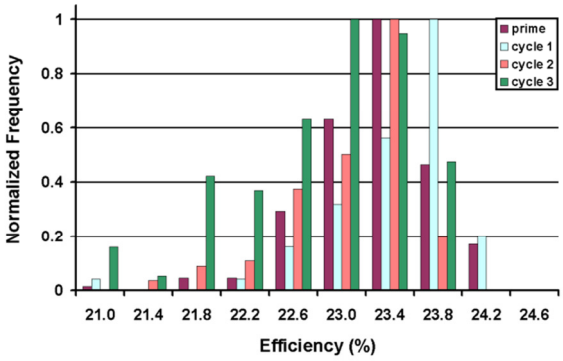

Fig. 5 Histogram of solar cell efficiencies showing device performance through three successive substrate reuse cycles.