World-highest-efficiency solar cells and low-cost III-V technology

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III-V multi-junction cells are unsurpassed in the efficiency of sunlight to electrical energy conversion. At Fraunhofer ISE we have recently demonstrated a solar efficiency under concentrated sunlight of 46% for a four-junction device. Despite this tremendous advantage in efficiency, III-V solar cells have a market share < 0.1% for terrestrial applications. In order to penetrate further into the market a significant cost reduction is needed. Cost drivers include high fabrication costs due to moderate throughput of metalorganic vapour phase epitaxy (MOVPE) reactors and the cost of III-V substrates.

The first part of the talk will address our approach on reducing the fabrication cost by increasing the growth rate. Recently we have achieved a growth rate of 100 μm/hr for GaAs - a result significantly above typical deposition rates for MOVPE processes.

The second part will address our work on III-V on silicon for multi-junction solar cells with an active silicon bottom cell. Here, we have recently surpassed the auger limit for the conversion efficiency of 29.4% (one sun) for silicon solar cells with a wafer bonded GaInP/GaAs//Si triple junction cell with a conversion efficiency of 30.2% (AM1.5g), showing the high potential of this approach. We also follow the path of direct growth of III-V on silicon. Recent results of directly grown triple junction cells on silicon will be presented.