

New approaches for Beyond-Silicon Photovoltaics

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The recent rapid drop of solar module prices and global growth of photovoltaics has moved the scientific research frontiers for solar energy conversion towards new challenges and opportunities, including tandem photovoltaic structures that have potential to leverage the manufacturing base for Si photovoltaics. Highly luminescent III-V semiconductors have opened new directions for ultrahigh efficiency photovoltaics, but these must also compete on cost; I will describe three new directions. First, I describe a luminescent solar concentrator concept that uses quantum dot luminophores to enable 30-100x concentration of diffuse sunlight onto small III-V compound semiconductor cells, which in a tandem-on-Si configuration has potential for beyond-Si module efficiencies. Another direction towards achieving cost-effective III-V tandem-on-Si structures employs top cells prepared via epitaxy-free and vacuum-free processing methods. Finally, emerging two-dimensional semiconductor materials such as transition metal dichalcogenides (TMDCs) and layered perovskites with high luminescence yields and favorable bandgaps are interesting candidates for tandem photovoltaics. I will discuss progress on TMDC photovoltaics and paths for tandem integration.