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High-temperature solar cells

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The conversion of light to electricity can be done indirectly by first converting light to high-temperature heat and then heat to electricity or directly using solar cells. These processes are today carried out on a large scale in physically separate solar plants. The indirect process is limited by the thermodynamically dictated Carnot efficiency while the direct conversion efficiency has an upper bound the Shockley-Queisser limit. Is there a way to overcome these efficiency limitations without violating physical laws? Clearly, a way dramatically to lower solar electricity costs would be to combine both processes in a single solar power plant facility without substantially increasing its capital cost. Such a hybrid procedure would effectively double the conversion efficiency but it would require the use of solar cells that operate at 400 Centigrade or above. Such cells do not exist today and therefore this attractive approach cannot be implemented. This presentation focuses on recent breakthrough developments in condensed matter physics and chemistry that are anticipated to lead to the creation of a new generation of high-temperature solar cells. Spectacular advances have occurred in the synthesis and nanophotonics of wide band-gap (WBG) semiconductors as well as in understanding the unique quantum electrodynamic properties of graphene for which the 2010 Nobel Prize in Physics was awarded. The p/n heterojunctions between these two materials are predicted to allow very effective separation of electron/hole pairs formed in graphene by the absorption of the total solar spectrum waveguided along the length of the WBG nanowires. These materials were selected because their electronic structures are influenced only minimally by increasing temperature and because these materials are not resource limited as well as being environmentally benign.

Biography

Dieter M Gruen received his PhD at the University of Chicago in Chemical Physics. He is an Argonne Distinguished Fellow, Emeritus and President of Dimerond Technologies LLC. He is an internationally recognized scientist and innovator with more than 400 publications.

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