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Abstract of Presentation

<u>Presentation Title:</u>

Intermediate band solar cell and quantum dot technology for high-efficiency photovoltaics

<u>Abstract :</u>

Low-dimensional quantum dots have attracted intense research as a possible means of exploiting the below bandgap photons to generate additional photocurrent beyond that corresponding to the band-to-band transition in the conventional single-junction solar cell. In intermediate band solar cell, as first proposed by Prof. Luque (Universidad Politécnica de Madrid), quantum dots are required to be uniform in size and periodically distributed in all three dimensions, which would then result in the formation of a miniband instead of a multiplicity of discrete quantized levels. With optimized bandgap energies of quantum dots and host material as well as the position and width of the intermediate band, high conversion efficiencies >50% are theoretically possible.

Our group at the University of Tokyo is currently investigating GaAs-based p-i-n quantum dot solar cells with up to 20 and more stacked layers of self-assembled InAs quantum dots grown by atomic hydrogen-assisted molecular beam epitaxy. Compensating for the compressive strain induced by InAs quantum dots with a spacer layer that produces an opposite tensile strain such as GaNAs dilute nitride is shown to work very well to obtain much improved size uniformity, redshift of absorption edge into infra-red wavelengths, and to avoid generation of defects and dislocations. The total quantum dot density of our solar cell with 20 InAs dot stacks we have achieved to date is on the order of $10^{12}/cm^2$, and the short-circuit current density is 21.1 mA/cm^2. The filtered current above GaAs bandedge of 2.5mA/cm^2 is four times higher than that for a strained quantum dot solar cell without strain control with the identical cell structure.