

Abstract of Presentation

Michio Kondo

Presentation Title(Should be no more than 20 words):

Materials for new energy solutions ; Novel materials have a big impact on innovative solar cells.

Abstract :

Solar photovoltaics is a promising pillar of carbon-free and sustainable energy resource. The issues are, however, high cost and low efficiency of power generation as compared to other renewable energy such as wind power. The solutions will be materials and processing to achieve lower cost and higher performance.

Solar cell efficiency is limited by spectral mismatch and fundamental generation and recombination losses. The spectral mismatch originates from the absorption loss in the long wavelength due to the band gap and the thermal relaxation of hot carriers excited by the shorter wavelength light. Those losses can be reduced by the multi-band gap techniques using various kinds of band gap materials such as InGaP ($E_g \sim 1.9$ eV), GaAs (1.4 eV) and Ge (0.7 eV). The combination of the materials, however, is quite limited due to the restriction of band gap, lattice mismatch and material quality. The further improvement requires the development of novel material itself and/or material processing. For instance, lattice-mismatch combination of InGaP(1.75 eV),GaAs (1.2 eV) and Ge(0.67 eV) has a higher potential for efficiency but the formation of buffer layer to avoid the dislocation due to the lattice mismatch is critical and delicate processing as demonstrated recently.

Silicon based solar cell is still a viable technology because of its reasonably high efficiency and reliable mass production technology. The major limitation is availability of the high purity material and its cost. The upgraded metallurgical silicon is a possible candidate in the future but the material has not yet been fully proven as a material for high performance and reliability. Particularly n-type single crystalline silicon would be a key material.

Novel concept such as photonic enhancement of light trapping, quantum size effect utilized for multi-photon absorption or multi exciton generation. Those technologies are expected to realize nearly physical limit of solar cell efficiency up to 60 %.

Material synthesis is thus essential and can bring a big impact on innovative solar cells.