Enhanced power conversion efficiency of solution based CIGSSe solar cells by band-gap grading

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CIGSSe is known to have many beneficial properties, such as favorable optical properties (e.g. direct energy band gap and high absorption coefficient) and stable structure, to fabricate durable solar cells. Particularly, CIGSSe also has a very attractive property in that the band-gap of the material can easily be tuned by controlling the composition. This enables for graded band gap in the film, which can enhance the solar cell performance by reducing recombination and improving photocurrent due to field assisted carrier collection. In this study, band-gap graded CIGSSe thin films were synthesized by a simple paste coating method and subsequent heat treatment under air and a S/Se atmosphere. The chalcogenization process induced self-graded composition distribution in the film and this uneven compositional distribution was confirmed to lead to a bandgap gradient in the film, which may also be responsible for enhancement in the open circuit voltage and reduction in photocurrent loss, thus increasing the overall efficiency. The highest power conversion efficiency of 11.7% was achieved with J_{sc} of 28.3 mA/cm^2, V_{oc} of 601 mV, and FF of 68.6%.