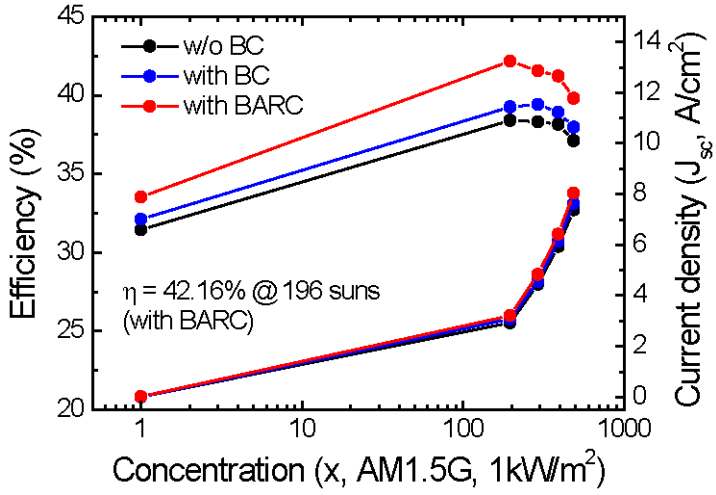

Fig. 5. Power conversion efficiency and current density of CPV sub-receiver modules with three different types as a function of light concentration ratio.

Under the light concentration, the cell efficiency increased due to the increased V_{oc} and fill factor. Figure 5 illustrates the power conversion efficiency and J_{sc} of the CPV sub-receiver modules versus the light concentration ratio. A strong increase in power conversion efficiency was shown in all three curves, and these have a roll-over point at around 200 - 300 suns, which results from the decreased fill factor by the increased series resistance of the cells [23]. The modules with BC and BARC exhibit the improved power conversion performance in comparison to the modules uncovered by glass and resin, which is mainly caused by the increased J_{sc}. The tendency of the enhanced efficiency was sustained at high concentration ratio, and the maximum efficiency of the sub-receiver module with BARC was achieved at 42.16% for 196 suns, which is a 7.41% boosted value, relative to the use of conventional coverglasses.

4. Conclusion

To improve the power conversion efficiency of a III-V based CPV sub-receiver module, the moth eye structures were fabricated on a coverglass substrate using thermally dewetted Ag NPs, and their optical characteristics were investigated in terms of wavelength, together with a theoretical calculation using the RCWA method. The fabricated moth eye structures on the coverglass substrate showed very high transmittance compared to the sample with a flat surface over the full solar spectral range (300 - 1800 nm). Also, the fabricated CPV sub-receiver module with BARCs showed an increased J_{sc} both in one sun and high concentration mode, without any detrimental changes. From these results, we expect that the use of BARCs may provide a promising potential for various photovoltaic devices.

Acknowledgment

This work was partly supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (no. 2011-0017606), by the World Class University (WCU) program at GIST through a grant provided by MEST of Korea (R31-20008-000-10026-0), and by the Core Technology Development Program for Next generation Solar Cells of Research Institute for Solar and Sustainable Energies (RISE), GIST. The authors would like to acknowledge Mr. Sooraj Ravindran in GIST for his fruitful comments and suggestions.

#172541 - $15.00 USD Received 23 Aug 2012; revised 21 Sep 2012; accepted 25 Sep 2012; published 15 Oct 2012