Upscaling of polymer solar cell fabrication using full roll-to-roll processing

Upscaling of the manufacture of polymer solar cells is detailed with emphasis on cost analysis and practical approach. The device modules were prepared using both slot-die coating and screen printing the active layers in the form of stripes that were serially connected. The stripe width was varied and the resultant performance analysed. Wider stripes give access to higher geometric fill factors and lower aperture loss while they also present larger sheet resistive losses. An optimum was found through preparation of serially connected stripes having widths of 9, 13 and 18 mm with nominal geometric fill factors (excluding bus bars) of 50, 67 and 75% respectively. In addition modules with lengths of 6, 10, 20, 22.5 and 25 cm were explored. The devices were prepared by full roll-to-roll solution processing in a web width of 305 mm and roll lengths of up to 200 m. The devices were encapsulated with a barrier material in a full roll-to-roll process using standard adhesives giving the devices excellent stability during storage and operation. The total area of processed polymer solar cell was around 60 m2 per run. The solar cells were characterised using a roll-to-roll system comprising a solar simulator and an IV-curve tracer. After characterisation the solar cell modules were cut into sheets using a sheeting machine and contacted using button contacts applied by crimping. Based on this a detailed cost analysis was made showing that it is possible to prepare complete and contacted polymer solar cell modules on this scale at an area cost of 89 m-2 and an electricity cost of 8.1 Wp-1. The cost analysis was separated into the manufacturing cost, materials cost and also the capital investment required for setting up a complete production plant on this scale. Even though the cost in Wp-1 is comparable to the cost for electricity using existing technologies the levelized cost of electricity (LCOE) is expected to be significantly higher than the existing technologies due to the inferior operational lifetime. The presented devices are thus competitive for consumer electronics but ill-suited for on-grid electricity production in their current form.

General information
State: Published
Organisations: Electrochemical Evaluation, Solar Energy Programme, Risø National Laboratory for Sustainable Energy
Contributors: Krebs, F. C., Tromholt, T., Jørgensen, M.
Pages: 873-886
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Nanoscale
Volume: 2
Issue number: 6
ISSN (Print): 2040-3364
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.57 SJR 2.934 SNIP 1.442
Web of Science (2017): Impact factor 7.233
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.46 SJR 2.789 SNIP 1.441
Web of Science (2016): Impact factor 7.367
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 7.97 SJR 2.77 SNIP 1.542
Web of Science (2015): Impact factor 7.76
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 7.64 SJR 2.646 SNIP 1.649
Web of Science (2014): Impact factor 7.394
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 6.89 SJR 2.558 SNIP 1.467
Web of Science (2013): Impact factor 6.739
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes