Polydimethylsiloxane Microlens-enhanced Flexible Gallium Arsenide Solar Cells to Increase Driving Range of Electric Automobiles

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An untapped technology to increase driving range of electric cars is solar cells to provide auxiliary power output. But, the limited power output of conventional silicon panels and their inflexibility make them unsuitable for electric cars. It is possible to double the power output using gallium arsenide (GaAs) solar cells and with concentrated light. But these solar cells are expensive; also concentrated light requires complex and expensive optics. A two-part solution has been developed–flexible GaAs microcells and inexpensive Polydimethylsiloxane (PDMS) microlens. GaAs microcells 250μm diameter were fabricated on flexible substrates using photolithography. The photovoltaic parameters of the GaAs cells were determined from current-voltage characteristics at 1 sun with and without PDMS microlens and at 10 suns with conventional concentrator. Experiments were also done at different light incidence angles (0–60º) to simulate sunlight conditions during day-long drive. The results show that the simple and inexpensive PDMS microlens increases the power output of GaAs microcells ~8 times before anti-reflective coating (ARC) and ~10 times after ARC. The enhanced power output with PDMS microlens persisted even at large light incidence angles. Even at 45º, the power output from a PDMS microlens-enhanced GaAs microcell was 82% of the maximum power. At this angle, its power output was 83% higher than that obtained using a complex and bulky light concentrator. GaAs microcell arrays using PDMS microconcentrators offer the combination of flexibility, lower cost, and higher power output that can enable roof-top photovoltaics for electric automobiles and extend their range as much as 50 miles.