Reusable Moth-Eye nano-patterned PDMS sticker as a versatile function of coating for photovoltaics.

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In solar photovoltaic systems, enhancing absorption of the incident light on the device surface through reducing reflection is crucial for improving the system performance. In the traditional layered method for anti-reflective coatings (ARCs), however, there are not a few limitations in achieving ARCs, because it depends on the wavelength, angle, and polarization of the incident light.[1] [2] On the contrary, the bio-inspired nanostructures provide amazing multifunctional properties as well as those overcoming the limitations of the traditional layered ARCs, e.g. broadband and quasi-omnidirectional antireflection, hydrophilicity-based antifogging, and super-hydrophobicity-based self-cleaning in combination with optical, mechanical, and adhesion properties. When it comes to anti-reflective properties, especially moth-eye nanostructures exhibit exceptional broadband and wide-angle performances compared to the conventional ARCs.

In the present work, using polydimethylsiloxane (PDMS) which is most widely used and have such advantageous material properties as easily controllable morphology, adherence to the flexible substrate, ease of large-area fabrication and so on, moth-eye nano-patterned ARCs which are protuberant, aspect ratio >1 long and truncated corn-like shape are made for both the photovoltaic performance enhancement and the device surface protection. Here, the nanostructured PDMS sticker was replicated by soft imprint lithography using Si master prepared through self-assembly lithography with three different sizes of polysterene (PS) beads.

There are two novelties in this work. The first, in contrast with the previously reported ARCs which are fixed in the device itself, the moth-eye nano-patterned PDMS ARC of this work is free from the device with the ability both repeatedly attachable and easily detachable just like a sticker. And the second, there is little work on the protuberantly nano-patterned PDMS with high aspect ratio (>1) due to the fabrication difficulty attributed to PDMS nanostructures' collapse and clustering while hollow patterns on PDMS are well researched. The PDMS film of this work is expected to be useful to such fields as flat panel displays, photodetectors, solar cells, etc and even applicable to the devices themselves in the preexisting conditions.

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[1] S. Chattopadhyay, Y. F. Huang, Y. J. Jen, A. Ganguly, K. H. Chen, and L.C. Chen : Materials Science and Engineering, R, 2010, 69, 1-35

[2] Jinguang Cai and Limin Qi : mater. Horiz., 2015, 2, 37-53

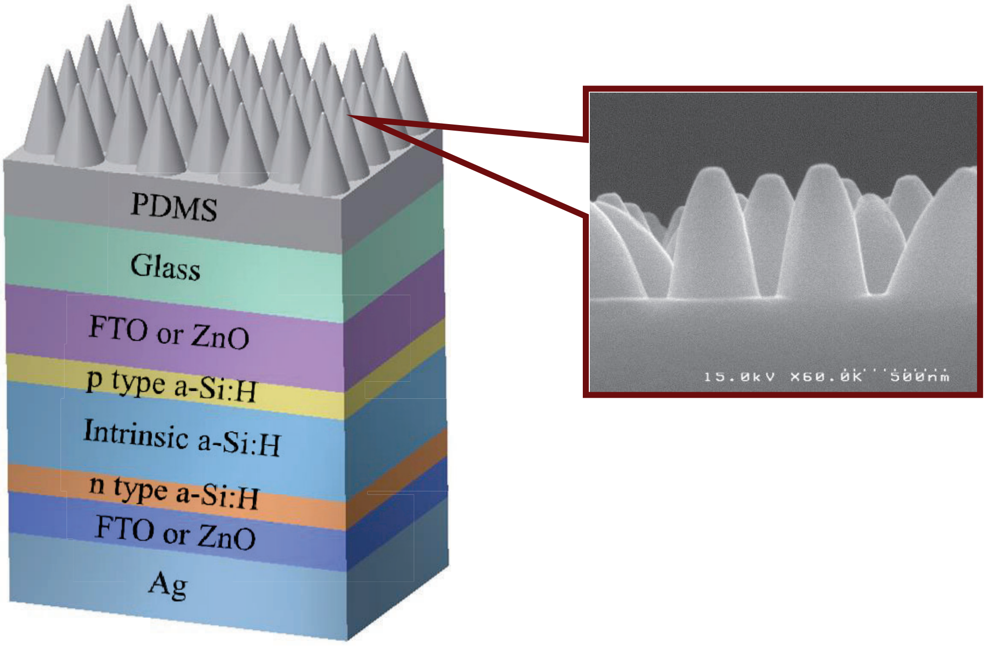

Figure 1: The schematic structure of moth-eye nano-patterned PDMS-attached solar cell and the SEM image of 0.57µm diameter polysterene (PS) bead-patterned PDMS.

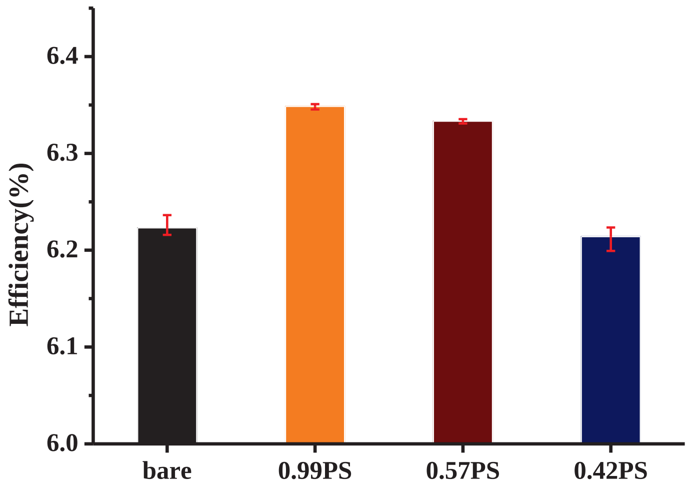

Figure 2: Power Conversion Efficiency (PCE): Bare represents the case where no nano-patterned PDMS film is on the a-Si solar cell while 0.99PS, 0.57PS, 0.42PS represent those in which three different diameter 0.99µm, 0.57µm, 0.42µm respectively of polysterene (PS) bead-patterned PDMS film is on the a-Si solar cell.