Researchers Review Graphene's Potential and Limitations for Cooling Solar Panels

Researchers at Monash University Malaysia and Tunku Abdul Rahman University of Management and Technology have studied how graphene and graphene derivatives could be used as materials to reduce the operating temperature of solar panels. They reviewed the limitations and potential of solar module cooling techniques based on graphene and found that high costs and graphene treatments are the main challenges to overcome.

In a recent in-depth review, the team explained that graphene has attracted the interest of the scientific community as a medium to enhance heat transfers in cooling systems. When used for PV cooling applications, graphene can be used in different ways.

For example, as a selective absorber coating or embedding it into a working fluid as a nanofluid. Graphene nanoparticles can also be added to thermal interface materials (TIMs) or phase change materials (PCMs) used for solar module cooling. The group divided all graphene technologies applied to PV into two categories – passive and active cooling.

The first category was split into pre-illumination and post-illumination techniques. The latter involves all methods that use a heat receiver to dissipate heat generated from solar cells, while the former includes all approaches that decompose the sun spectrum before it reaches the PV cells.

The pre-illumination category is represented by all types of graphene-coated neutral density (GCND) filters used as selective absorber coating. The scientists explained that the application of the GCND filter as a pre-illumination passive cooling technique can be very advantageous, particularly in cooling CPV systems. This pre-illumination cooling technique attenuates the solar radiation before it reaches the PV panel, reducing the amount of heat generated at the PV panel.

They also recommended using GCND filters only for small-scale domestic applications, due to their high costs. They also recommended to reduce costs by focusing the graphene coating specifically at the focal spot instead of coating graphene across the entire substrate.

As for the post-illumination category, the list includes using graphene as a thermally conductive filler in TIMs and PCMs. They said that both TIM and PCM present advantages and disadvantages of their own, so there is no single answer to whether TIM or PCM in passive cooling of PV panels is better. The active cooling category includes all techniques based on graphene nanofluids configured as working fluids.

These techniques, like all active cooling methods, require the construction of pumps and pipes to circulate the nanofluid around the modules, which the scientists said raises significant production costs. The group acknowledged that more research will be required to reduce costs and improve cooling efficiency. The researchers also said that synthesizing graphene nanofluid and hybridizing graphene nanofluid and graphene-enhanced PCMs are the main technical challenges to overcome