The Enhancement of Forced Atmospheric Water Condensation Using Multilayer Graphene-Coated Porous Ceramic Substrates

Shahinyan, Albert (School: National Polytechnic University of Armenia Foundation Yerevan High School)

Freshwater scarcity affects over 50% of the current world population, making atmospheric water harvesting (AWH) an important field of research. This project utilizes mechanically exfoliated multilayer graphene (MLG) sheets to enhance AWH on a porous ceramic substrate. MLG sheets were deposited onto the porous ceramic tile by placing a small amount of graphite powder (99% purity, ~2um flake size) on it, after which a glass slide was pressed and moved in a circular motion for 3 minutes. After confirming ultrathin carbon deposits via optical microscopy, coated and uncoated tiles were placed in a sealed humid enclosure, where air temperature and relative humidity were logged every ten seconds using a DHT22 sensor. Using that data, the dew point, partial and saturation vapor pressure changes were calculated. Additionally, the sessile drop method was used to measure the contact angles of the coated and uncoated tiles. The coated tile demonstrated a 2 times increase in water collection over the uncoated tile, (20g vs 10g) over a 10 hour period, while being in a ~68% RH environment compared to the ~93% of the uncoated tile. Moreover, the coating reduced the theta contact angle by 27°, lowering the nucleation barrier by ~80%. These results and the DHT22 log data validated the theoretical framework. In conclusion, this solvent-free and scalable device proves that graphene can significantly enhance AWH on non-conductive substrates. The simplicity of the fabrication method combined with graphene's ability to enhance AWH in low humidity environments makes this a viable solution for large-scale AWH, even in arid regions.

Awards Won:

Third Award of $1,200