The material, developed by scientists at the U.S. Department of Energy's (DOE)Brookhaven National Laboratory and Los Alamos National Laboratory, consists of a semiconducting polymer doped with carbon-rich fullerenes – soccer-ball-shaped, cage-like molecules composed of 60 carbon atoms. When applied to a surface under carefully controlled conditions, the material self-assembles in a repeating pattern of micron-sized hexagonal-shaped cells resembling a honeycomb over a relatively large area (up to several millimeters).

The material is largely transparent because the polymer chains pack together only at the edges of the hexagons, remaining loosely packed and spread relatively thin across the centers. The densely packed edges strongly absorb light and could facilitate electrical conductivity, while the centers don't absorb much light and are relatively transparent, according to the researchers.

Combining these traits and perfecting large-scale patterning of the material could enable a wide range of practical applications, such as energy-generating solar windows, or even new types of optical displays.

The scientists fabricated the honeycomb thin films by creating a flow of micron-sized (about 1/100th the width of a human hair) water droplets across a thin layer of the polymer/fullerene blend solution. These water droplets self-assembled into large arrays within the polymer solution. As the solvent completely evaporates, the polymer forms a hexagonal honeycomb pattern over a large area. The scientists say this method is cost effective and potentially scalable to industrial size production.

They also found that the degree of polymer packing was determined by the rate of solvent evaporation – the slower it evaporates, the more tightly packed the polymer and the better the better the charge transport.