Recapping 2020’s Top Nanotechnologies for Life: UCLA Scientists Create World’s Smallest ‘Refrigerator’

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Developing the world’s smallest refrigerator, Prof. Regan’s group at UCLA University are successfully reporting on this event occurrence and related specific measurement methods utilizing thermoelectric coolers engineered in nanoscale.

Everyday routine devices, namely refrigerators are not normally assumed to be scientifically as complicated as electron macroscopy apparatus and physics, but they may appear relevant in some ways utilizing advanced material science. Due to the demand for regulating temperature in fiber-optic networks or increasing image quality by a reduction in image noise of high-end telescopes, thermoelectric coolers (TECs) in computers and electronic devices have been previously sounding familiar.

Hereafter, according to the explained basis, a group working on TECs has recently developed the yet found most undersized and minimal refrigerator with the 100-nanometer thickness and additionally designed the related methods for temperature measurements or other functionality criterions quantifications under prof. Chris Reyan guidance in UCLA University (resultant paper is actually provided in ACS Nano journal).

To clarify the specifications of the main system, it can be concisely mentioned that two semi-conductors are trapped between metalized plates with the capability of performing in two different categories as creating electricity by temperature change and actually the reverse procedure.

In more details, while one side heats to a distinct temperature and the other side stays cool in the previous thermal situation, this difference results in electricity production and inversely as electricity pass through the device, plates obtain different temperatures. For instance, the referred system is the basis of existed NASA spacecraft electricity supplying source which is located near plutonium planet for several years.

In fact, the reverse procedure is the inspiring subject which has been the spark for minimal nano-size or even macro-size cooling devices development under an electrical current flow passing through the designed instrument. Moreover, in the aforementioned project, bismuth telluride and antimony-bismuth telluride as two chosen semi-conductors, are prepared by detaching an attached tape placed on related bulk materials surface leading to the presence of a single-crystal flakes layer remaining on the tape side which provides the required starting matter.

The thickness of the considered produced layer is approximately 100 nm with a surface of 1 square micron. The proposed challenges about the minimal refrigerators are briefly addressed as lack of moving parts, low reliability and, low efficiency in comparison to former compression-based instruments which means these thermoelectric coolers cannot decrease the temperature to a favorable degree yet.

Therefore, named group are progressing routes of TECs devices efficiency enhancement and by noting two important aspects of a desirable cooler as high electrical conductivity and additionally low thermal conductivity, synthesized almost two-dimensional materials are probable of showing these enumerated favorable features.

In the following, due to the designed system’s small size, fast response ability is pointed out to be the other interesting property. To investigate the details of the next important achievement mentioned as a new thermometric procedure, this group has developed a density calculation system utilizing transmission electron microscopy which is named as "plasmon energy expansion thermometry" (PEET). In the PEET method, indium nanoparticles stick to one side of the two connected semi-conductors and by temperature alteration, hole density change is measured to indicate specific temperature and temperature gradient in nanoscale based on done calibration.

Parallel to the explained method, another proving procedure called "condensation thermometry" is running in accordance with the dew point of water. Indeed, present vapor in the air condenses while temperature decreases and droplets are observed using optical microscopes.

Finally, it worth mentioning that ordinary devices and events can be observed from other points of view using advanced developing science in real creative platforms which may lead

to fascinating inventions.

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