Can Nanophotonics Help to Combat Energy Problem?

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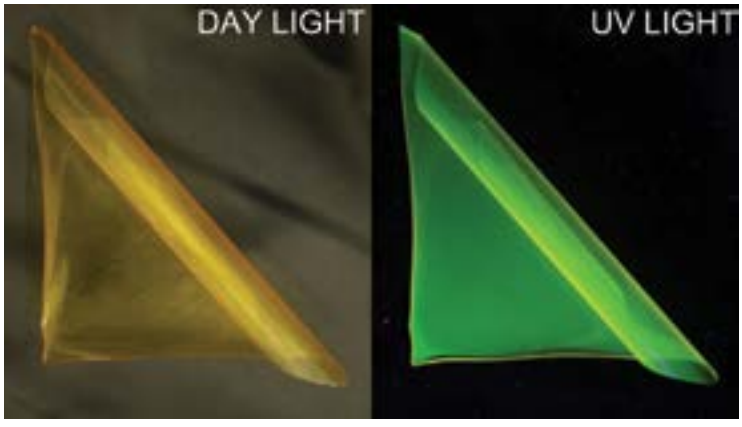
Nanophotonics can simply be defined as the study of light-matter interactions at the nanometer scale and can potentially find its place in energy related research studies, e.g., for generating light with less energy consumption, harvesting light more efficiently and reducing the polluting emission using photocatalytic activity. Our energy future is a growing and universal problem to be addressed collectively. For sustainable Earth, reducing energy consumption, increasing alternative energy sources and decreasing polluting emission are crucial. As a remedial action, there are different possible approaches. The Devices and Sensors Research Group at Bilkent University and UNAM (Ankara, Turkey) under the supervision of Professor Hilmi Volkan Demir investigates innovative nanophotonic approaches to address the global energy problem. The Demir Group has been working on innovative chip-scale nanophotonic and optoelectronic platforms, embedded with nano- and micro-scale functional structures in hybrid architectures.

The Demir Group mainly focuses on efficient energy utilization and sustainable energy generation by developing new nanophotonic and optoelectronic systems. Among the Demir Group research projects are high-quality high-efficiency semiconductor LED lighting, FRET-based light generation and harvesting, energy transfer phenomena, and nanocrystal optoelectronics, metal nanoparticle and nanowire optoelectronics. Bilkent attracts the top high school graduates and faculty in the fields of fundamental sciences and engineering in Turkey. Bilkent prides on well-established research infrastructure along with UNAM facilities and ranks among the top in terms of research outputs in science/engineering in Turkey. With over 60 separate labs, UNAM houses state-of-the-art nanofabrication and nanocharacterization tools including TEM, ESEM, SEM, EBX, XPS, XRD, NMR, EBL, and FIB.

Professor Hilmi Volkan Demir



When the Demir Group at Bilkent started its research activities in 2005, the team focused on high-quality white light sources based on nanocrystal hybridization with tunable photometric properties. These nanocrystals exhibit favorable electronic and optical properties with their tunable bandgap by controlling their size. Making use of multiple combinations of nanocrystals, the Group demonstrated high-quality white light generation with tunable photometric properties (Nanotechnology and Nano Letters). The Group still holds the records of the best photometric performance of white LEDs (Optics

http://www.devicesandsensors.bilkent.edu.tr/en/

http://www.bilkent.edu.tr/~volkan/

www.n4e.eu

Letters and Applied Physics Letters) In parallel with these studies, the world's first nanocrystal based UV scintillator was carried out in the Demir Group, demonstrating doubled solar conversion efficiency in UV using amorphous silicon photovoltaic platform. (Optics Express). Promising results have been achieved by using nanopillar structure for enhanced photovoltaic efficiency as well. Likewise, by a comparative study of nanoparticles, a substantially enhanced photocatalytic activity has been achieved for massive environmental decontamination (Applied Catalysis B: Environmental). Recently, the Group has also reported large-area (over 50 cm × 50 cm) freestanding sheets of colloidal quantum dots (Nano Letters) and polarized emission using isotropic quantum dots in plasmonic cavities (ACS Nano).

The Demir Group is a partner of the Nanophotonics for Energy Efficiency (N4E) Network of Excellence, which focuses on nanophotonics research towards the challenges in energy efficiency. The Network clusters nanophotonic laboratories and research groups in Europe, combining their expertise in the development of disruptive approaches to lighting and solar cell technology. The consortium consolidates know-how and resources of 9 different institutions in 6 European countries with complementary research and development expertise, integrating over 130 scientists, engineers, technicians and managers in nanophotonics. Moreover, it is open to participation and collaborations with other stakeholders through two key instruments: Associate Membership and participation in the Seed Project scheme. The project pursues a scientific bottom-up approach to ensure that novel ideas and scientific breakthroughs as well as established proof-of-concepts in academia are promoted along the value chain towards reaching their eventual goal of commercialization. Market and industrial relevance is ensured through the involvement of industry leaders in the Advisory Board. This approach complements the existing top-down, industry-driven projects.

The Demir Group is also very active in synergic entrepreneurship activities in Turkey, Europe, the US and Asia, based on high-technology prototypes the Group have developed and in taking new ideas from the lab to the market. Professor Demir is a co-founder and a partner of several successful startup companies. Based on their joint research work and intellectual property, he first co-founded a nanotechnology based company, called InnovNano, which was then successfully turned into a joint venture, called InnovCoat, together with Materis, France.

As a result, the answer to the question of **"Can nanophotonics help to combat energy problem?"** is YES but a cautious yes… There are very important and promising results to be optimistic about but still there are some essential wide-scale commercialization efforts required for such scientific results to become practical.