Team develops a nanohybrid with remarkable properties using a new laser-plasma process

January 25 2013

By achieving the synthesis of a novel nanohybrid structure by means of the pulsed laser ablation (PLA) technique, Professor My Ali El Khakani and his team paved the way for a new generation of optoelectronic materials. The combination of carbon nanotubes and lead sulfide (PbS) nanoparticles was performed using an effective and relatively simple process that offers considerable latitude for creating other nanohybrids for a variety of applications. The INRS Énergie Matériaux Télécommunications Research Centre researcher's work, published in the renowned journal *Advanced Materials*, presents very promising prospects for the development of third-generation solar devices, fast photodetectors, and optoelectronic switches.

In recent years, research on the photoelectronic properties of semiconductor nanoparticles, such as PbS, has been growing. The coupling of these nanoparticles with carbon nanotubes is a promising strategy for effectively generating photocurrent. The synthesis methods used by other research teams had significant limitations. "When chemically synthesizing nanohybrids, researchers used ligands, which prevented nanoparticle agglomeration, on one hand, but significantly affected the charge transfer dynamics from nanoparticles to nanotubes," said Professor El Khakani. Ligands reduce photoresponse efficiency and increase the reaction time—two effects that were not observed in nanohybrids produced by PLA since PbS is in direct atomic contact with the nanotubes' surafce.

"At the beginning, we didn't know if the nanohybrids would form in such a way as to enable their effective use for photodetection," said Ibrahima Ka, an INRS doctoral student working under the supervision of Professor El Khakani and co-supervised by Professor Dongling Ma. "By optimizing our approach, we developed nanohybrids whose photoactivity can be almost tailored at will." By integrating the new nanohybrid material into functional photoconductive devices, the researchers were pleased to demonstrate its strong photoresponse, which overpasses the results obtained by other methods. Thus, they have been able to achieve photoresponse values as high as 670% at 633 nm and 1350% at 405 nm under conditions where other nanohybrids did not exceed 37%. Furthermore, when the material is illuminated by a laser, the photocurrent response time is 1,000 to 100,000 times faster than those reported to date for other nanohybrids.

The PLA synthesis process produces very pure nanostructures and provides greater control over nanohybrid characteristics. Professor El Khakani's results demonstrate the enormous potential of these carbon nanotubes with PbS quantum dots.

More information: The article entitled "Pulsed Laser Ablation based Direct Synthesis of Single-Wall Carbon Nanotube/PbS Quantum Dot Nanohybrids Exhibiting Strong, Spectrally Wide and Fast Photoresponse" was published in the journal *Advanced Materials* on December 11, 2012, (Vol. 24, pp. 6289)

Provided by INRS