Hybrid Nanophotonics for New Functionality

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Incorporation of custom-design nanomaterial into photonic devices and systems enables the realization of optical functionalities favorably controlled with external optical and electrical effects. In my research group, we work on the development of new hybrid nanophotonic devices and systems that consist of epitaxially grown, in-solution synthesized, and grinded nanostructures for the applications of light generation, modulation, sensing, imaging, displays, and communications in a wide spectral range from the ultraviolet (UV) to the visible.

In this talk, I will present examples of our hybrid devices and systems that incorporate GaN/InGaN and AlGaN/GaN quantum structures, CdSe/ZnS core-shell nanocyrstals, and TiO_2 nanoparticles. These include:

1.) our visible (blue) and UV quantum electroabsorption modulators, with which we demonstrated the world record-breaking blue-shifting electroabsorption in the blue range with the highest optical absorption change of 6000 cm^{-1} at 424 nm (corresponding to 50 cm^{-1} per 1V/µm field swing) for use in optical clock injection directly into silicon microelectronics;

2.) our visible and UV sources, with which we demonstrated the tunability of white light generation using multiple combinations of nanocrystals (up to quadruple combo) for the first time in the world and achieved the highest color rendering index (above 90) ever reported using organic-inorganic hybridization for use in high-quality white light generation;

3.) our nanocrystal hybridized scintillators, with which we demonstrated for the first time enhanced optical detection and imaging on Si platform in the deep UV (experimentally with a two orders of magnitude peak enhancement and theoretically with a three orders of magnitude peak enhancement between 200-240nm); and

4.) our UV photocatalytic organic-inorganic nanocomposite surfaces, with which we demonstrated evolution of optical spectral efficiency and strong size effect for the first time for use in environmental decontamination (e.g., NO_X reduction, in collaboration with DYO).

Biography:

Hilmi Volkan Demir received a B.Sc. degree in electrical and electronics engineering from Bilkent University in 1998, and M.S. and Ph.D. degrees in electrical engineering from Stanford University in 2000 and 2004, respectively. In September 2004, he joined Bilkent University, where he is currently Assistant Professor with joint appointments at the Department of Physics and the Department of Electrical and Electronics Engineering. He is the Associate Director of Nanotechnology Research Center and a faculty member of Advanced Research Laboratory.

Dr. Demir received the European Union Marie Curie IRG Fellowship in 2005, the Turkish National Academy of Sciences Distinguished Young Scientist Award and The Outstanding Young Persons Award of Junior Chamber International (JCI Worldwide Federation of Young Leaders and Entrepreneurs) in scientific leadership in 2006.