
L A S E R C O L L O Q U I U M

Environmental Photonics and Quantum Technologies: What can quantum tech do for the environment?

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ABSTRACT

Addressing urgent environmental challenges requires the implementation of advanced physical frameworks for sustainable energy harvesting, resource monitoring, and ultra-sensitive pollutant detection. In this presentation, the synergistic roles of photonic and quantum technologies in environmental monitoring and remediation are discussed. First, sustainable photonic approaches are examined, including waste-free surface texturing for enhanced light management in photovoltaic cells and plasmonic platforms for trace chemical sensing. Subsequently, quantum-enabled methodologies are reviewed, focusing on optically detected magnetic resonance (ODMR) utilizing diamond nitrogenvacancy NV- centers for high-precision subsurface and infrastructure diagnostics. Furthermore, the enhancement of hexagonal boron nitride (hBN) single-photon emitters via hybrid plasmonic nanocavities is demonstrated, and Quantum-Enhanced Raman Spectroscopy (QUPERS) is presented, wherein quantum path interference and Fano resonances are utilized to surpass classical vibrational detection limits.

ABOUT THE SPEAKER

Prof. Dr. Alpan Bek received his B.Sc. and M.Sc. degrees from the Department of Physics at Bilkent University, and his Ph.D. degree jointly from the Swiss Federal Institute of Technology Lausanne, EPFL, and the Max Planck Institute for Solid State Research in Stuttgart, Germany. He is currently a Professor in the Department of Physics and the Micro and Nanotechnology Graduate Program at Middle East Technical University, METU, Ankara, Turkey, where he leads the Environmental Photonics Research Group, with active affiliations at the METU Quantum Technologies Research Center and the Center for Solar Energy Research and Applications, ODTÜ-GÜNAM. His research is primarily centered on environmental photonics and quantum technologies, focusing on optical and quantum-enabled solutions to ecological and energy-related challenges. In this framework, his work spans advanced light management and lightinduced direct texturing for photovoltaics, ultra-sensitive plasmonic detection platforms for environmental pollutant sensing, and optical quantum magnetometry for precision geophysical and infrastructure monitoring. Additionally, his research group develops scalable single-photon sources coupled with

hybrid plasmonic cavities and Quantum-Enhanced Raman Spectroscopy platforms that harness quantum emitter–plasmon interactions to transcend conventional vibrational sensing limits.