

Quantum Information Science for Energy Sector Applications

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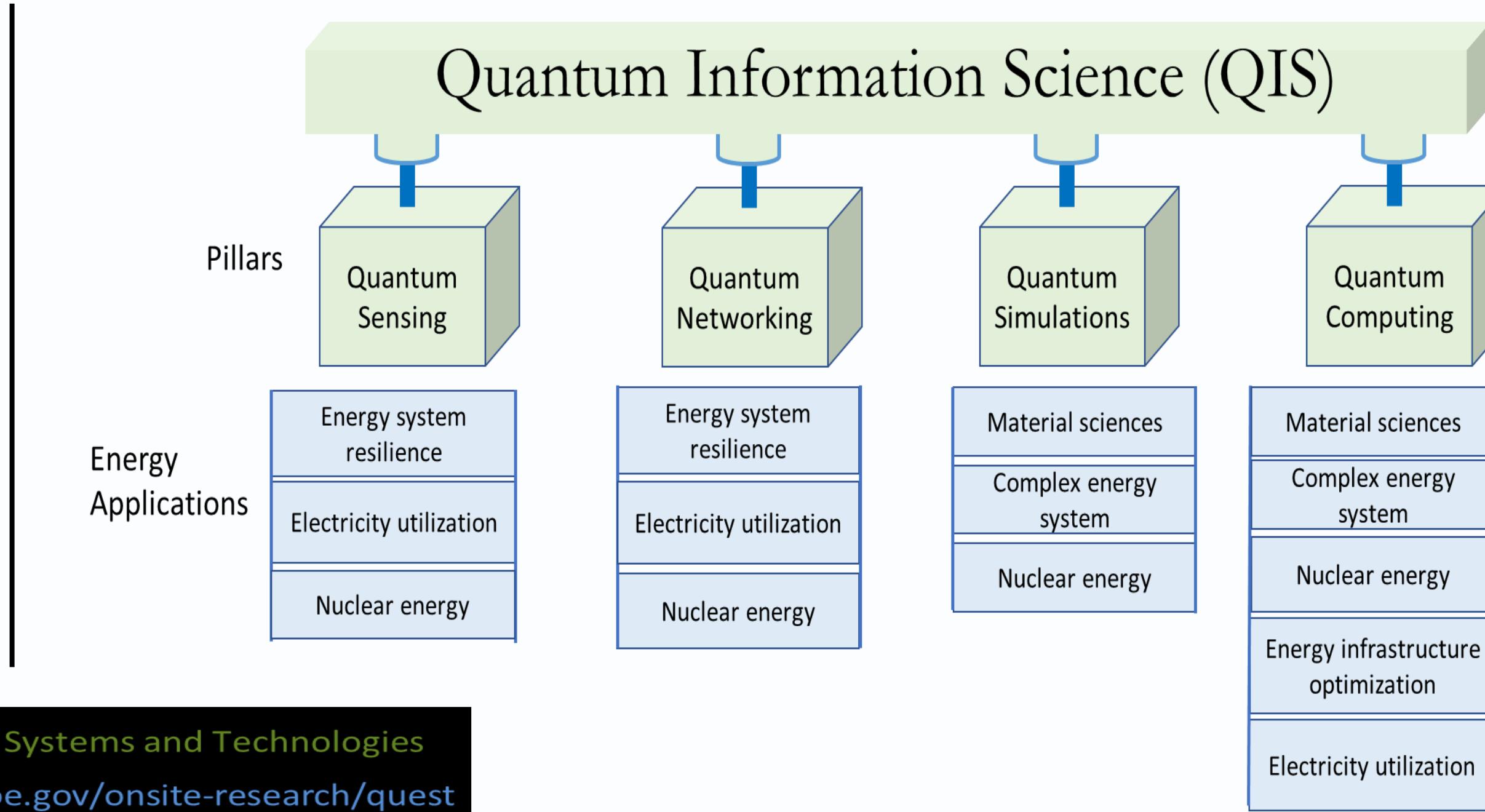
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Research & Innovation Center



Quantum Information Science for Energy Applications

On its revolutionary threshold, quantum sensing is creating potentially transformative opportunities to exploit intricate quantum mechanical phenomena in new ways to make highly sensitive measurements of multiple parameters. Concurrently, growing interest in quantum sensing has created opportunities for its deployment to improve processes pertaining to energy production, distribution, and consumption. In that spirit, NETL is leveraging experimental and computational quantum tools to enhance U.S. energy competitiveness.

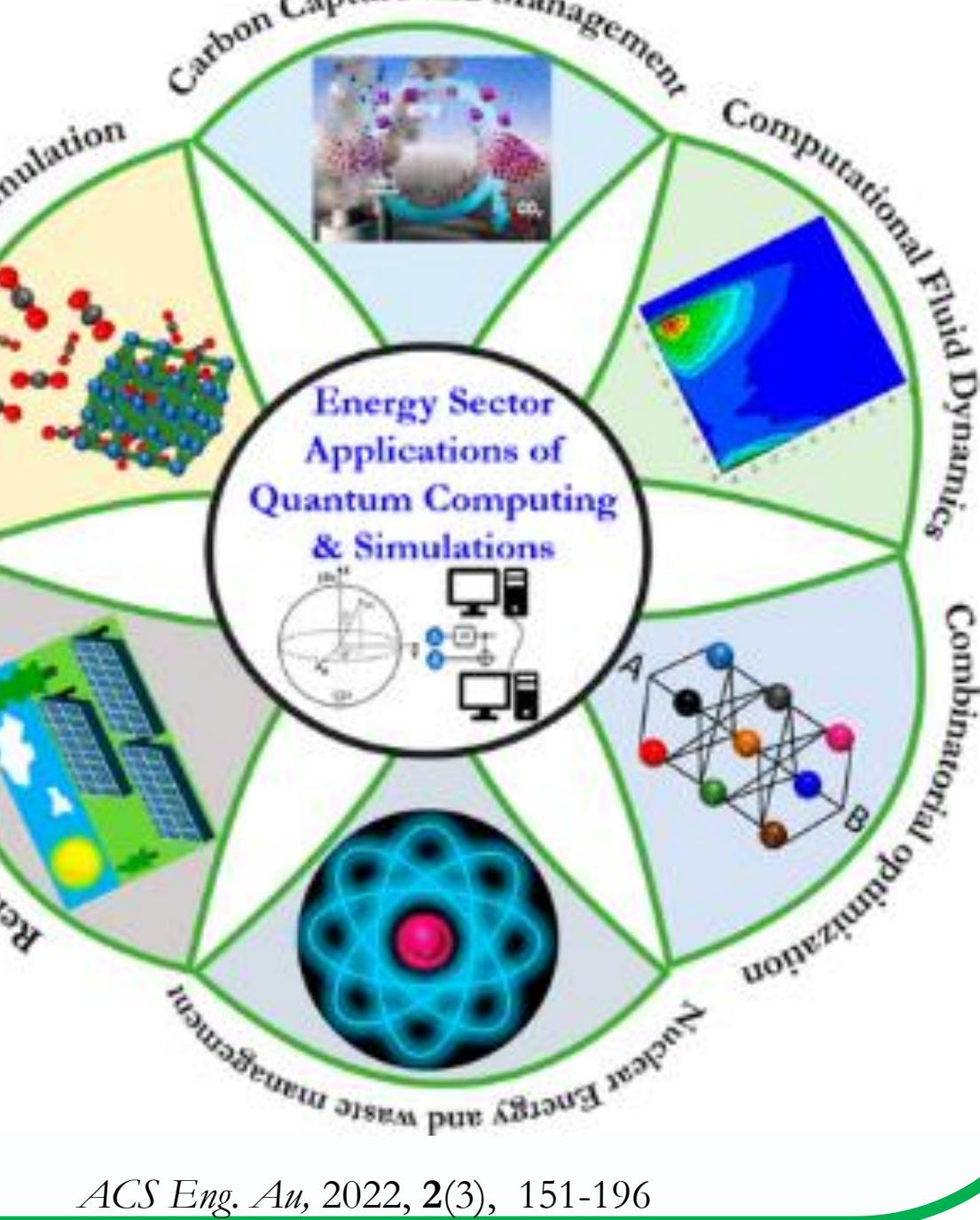
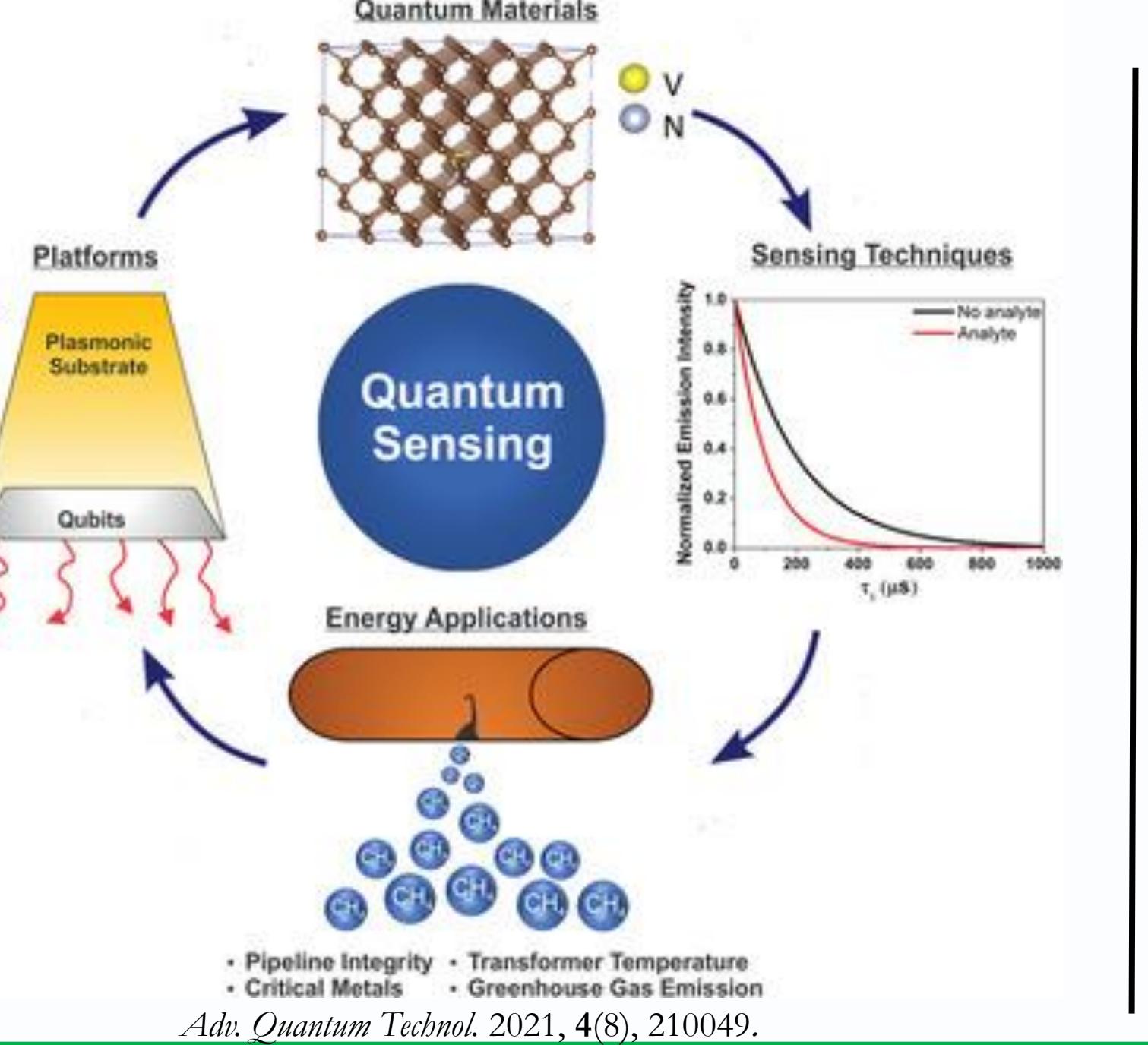


QUEST Quantum for Energy Systems and Technologies
<https://www.netl.doe.gov/onsite-research/quest>

Adv. Quantum Technol. 2021, 4, 8, 210049.

Identifying Critical Areas for QIS Deployment

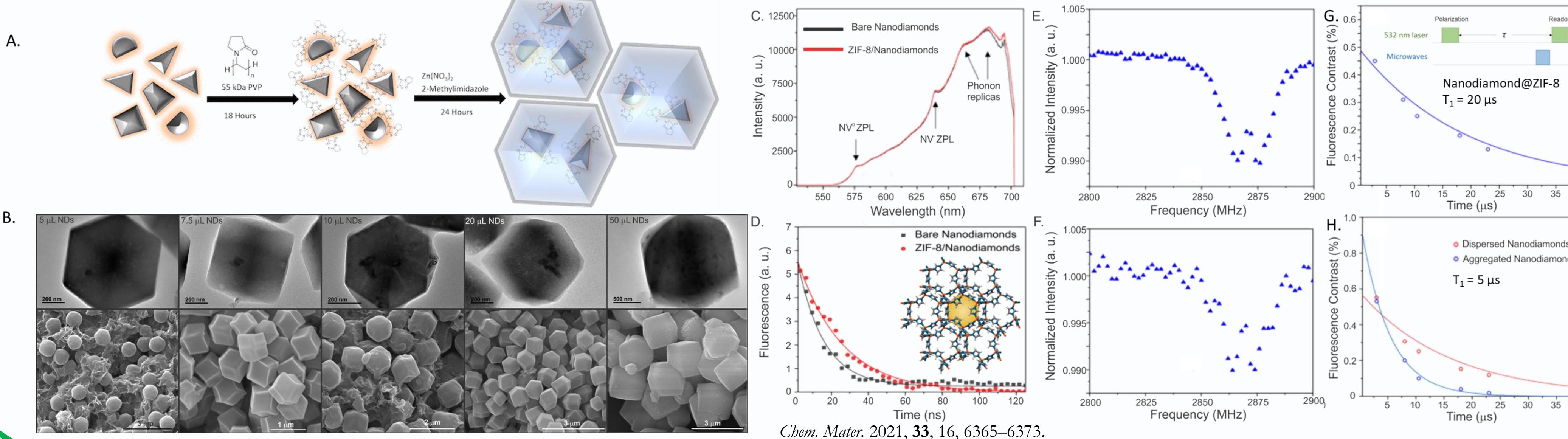
The application of rapidly evolving quantum technologies to real-world systems is challenging. Taking stock of the current state-of-the-art in QIS and identifying potential energy sector problems that could benefit from QIS represents a key first step. NETL has published two open-access comprehensive review articles on quantum computing and quantum sensing for energy, with a third in preparation.



ACS Eng. An. 2022, 2(3), 151-196

Nanodiamond/Metal-Organic Framework (MOF) Composites

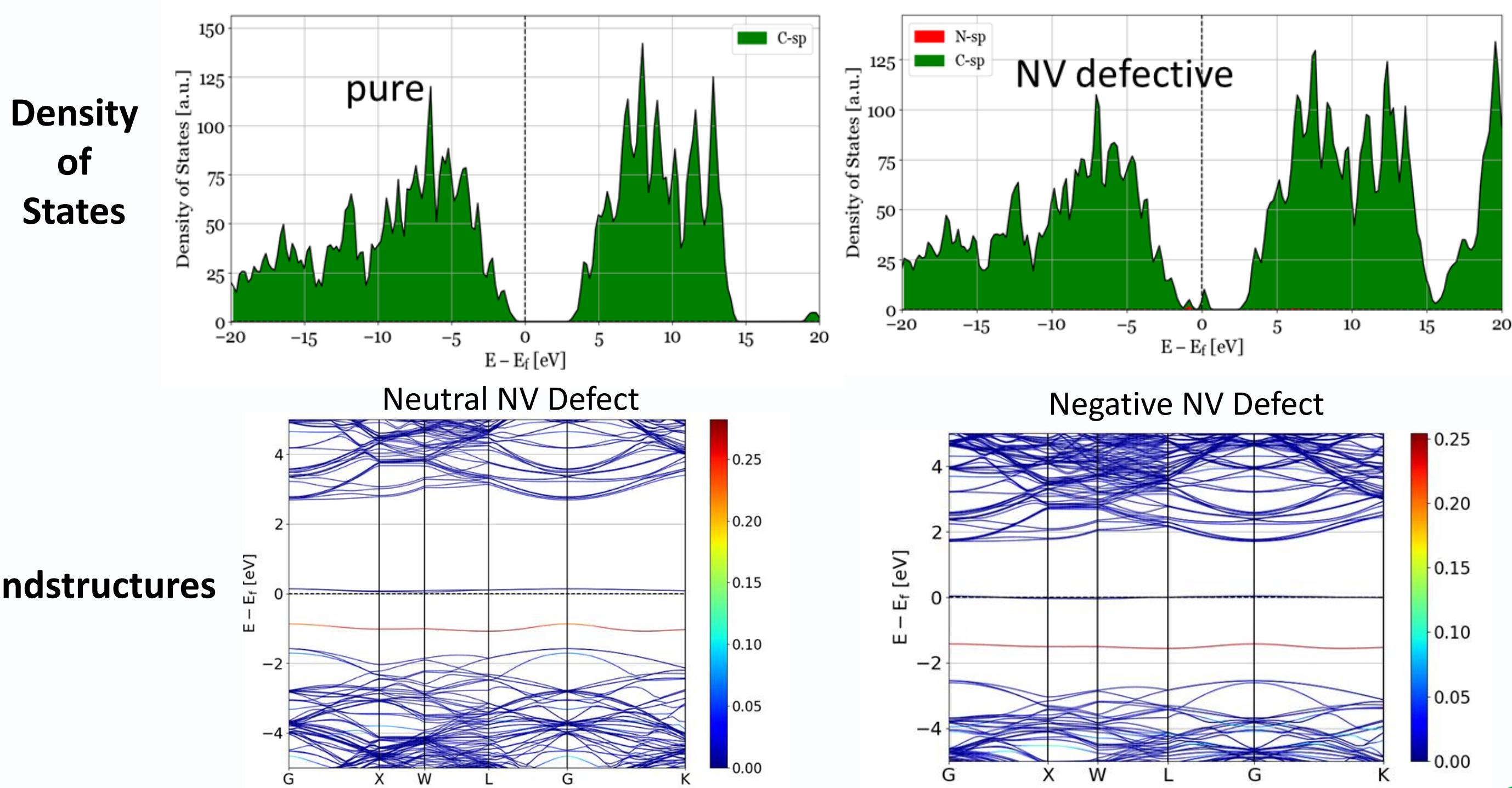
Functionalization of nanodiamonds with a porous coating provides a flexible scaffold for selective analyte uptake for quantum sensing. Here, a facile synthetic strategy is presented for the controlled encapsulation of nanodiamonds with the MOF ZIF-8. Quantum sensing properties are preserved, including an enhanced spin relaxometry performance.



Chem. Mater. 2021, 33, 16, 6365-6373.

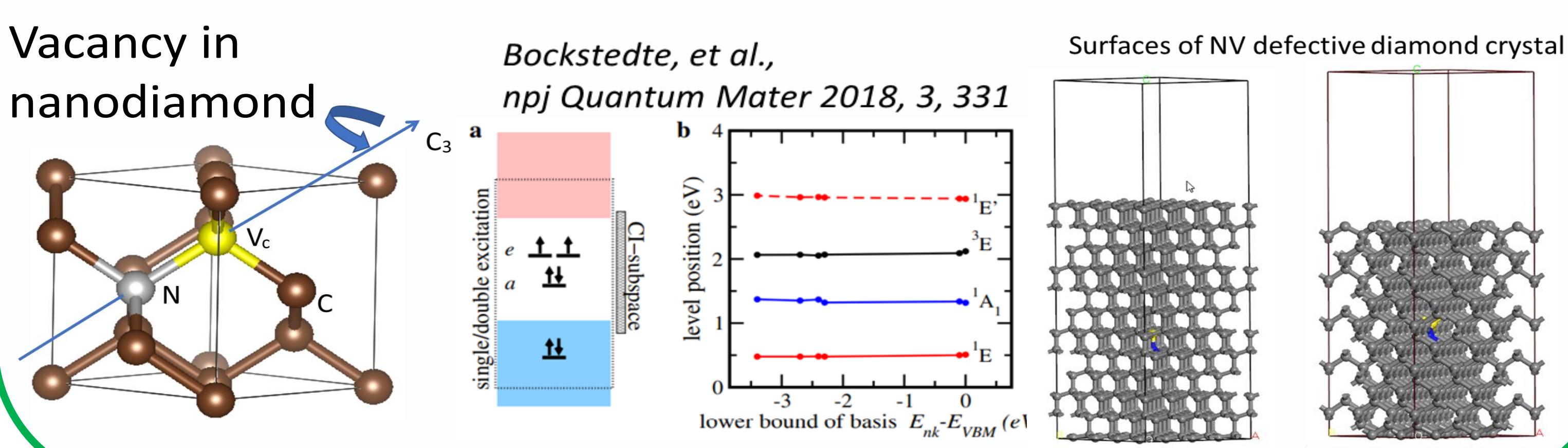
Modeling of Bulk and Surface of Diamond with NV Center

The role of changes in the electronic and optical properties of bulk diamond with N impurities and/or N with a carbon (C) vacancy defect on sensing-related applications is still not well understood. Diamond surfaces with a shallow NV center that are doped with different elements provide information on the electronic and optical signatures of spin-related properties. The density of states and bandstructures of diamond crystal provides insight on the light-matter interaction needed for optical sensing.



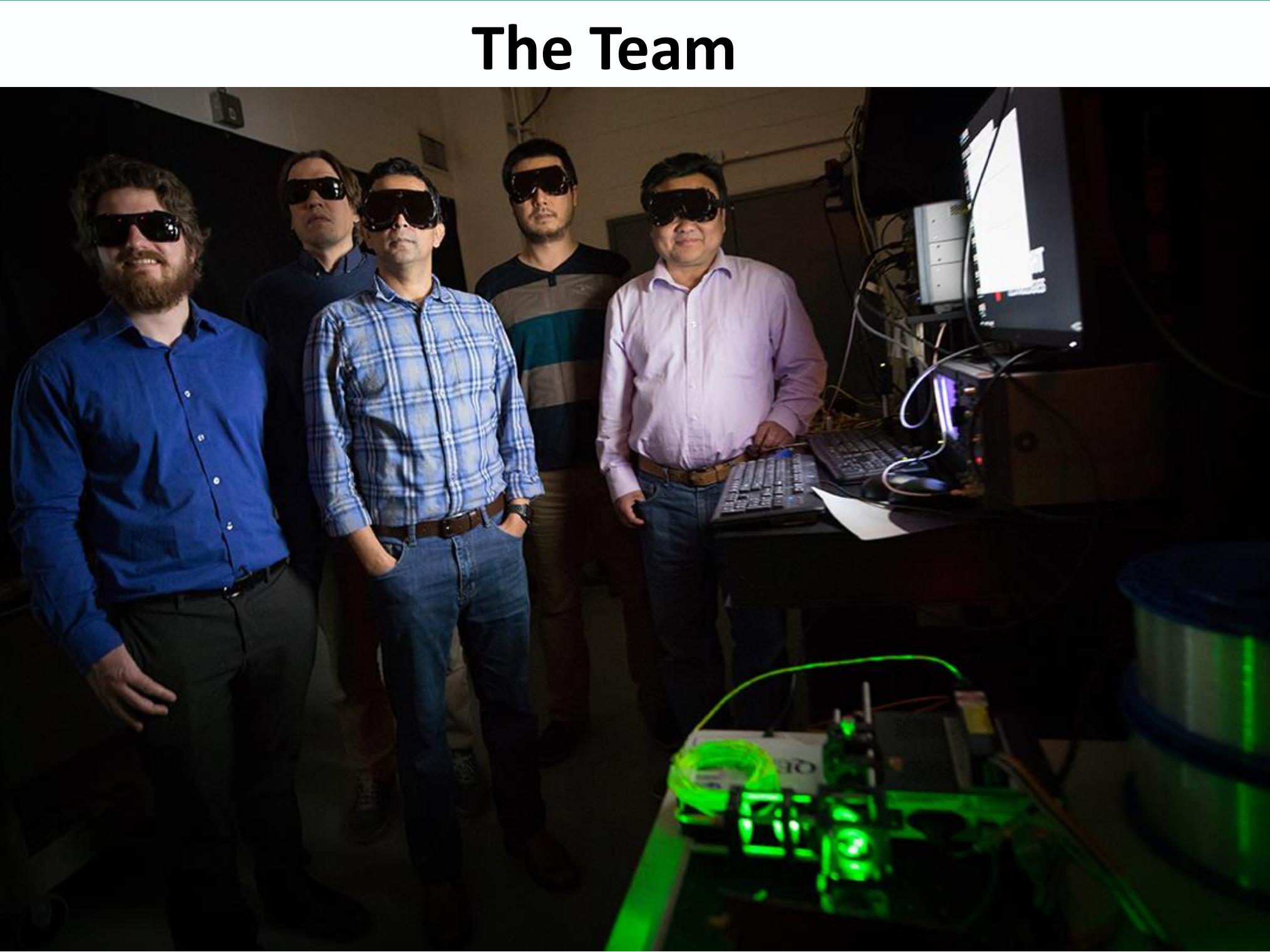
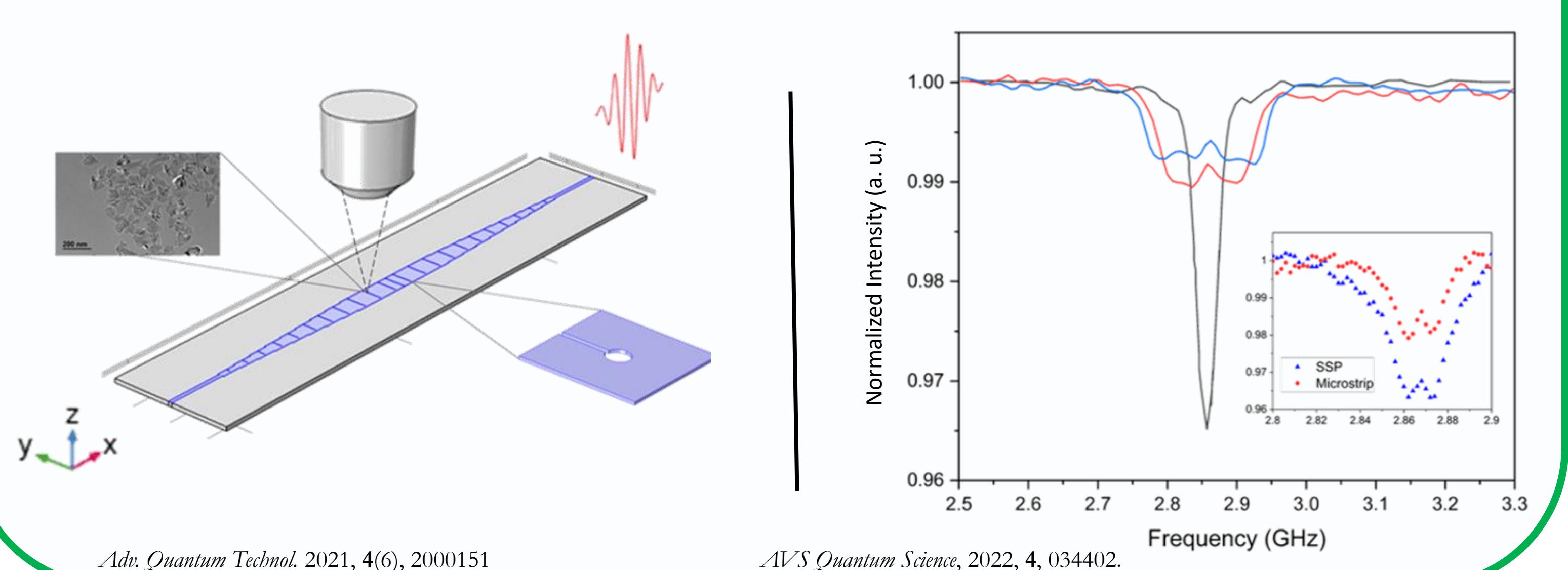
Modeling Diamond with a NV Center

In order to understand the defect properties and energy levels within the defect bands for different sensing applications, *ab initio* density functional (DFT) calculations are performed on the bulk and surface properties of the N (Nitrogen) and NV (Nitrogen vacancy) defective bulk and diamond surfaces.

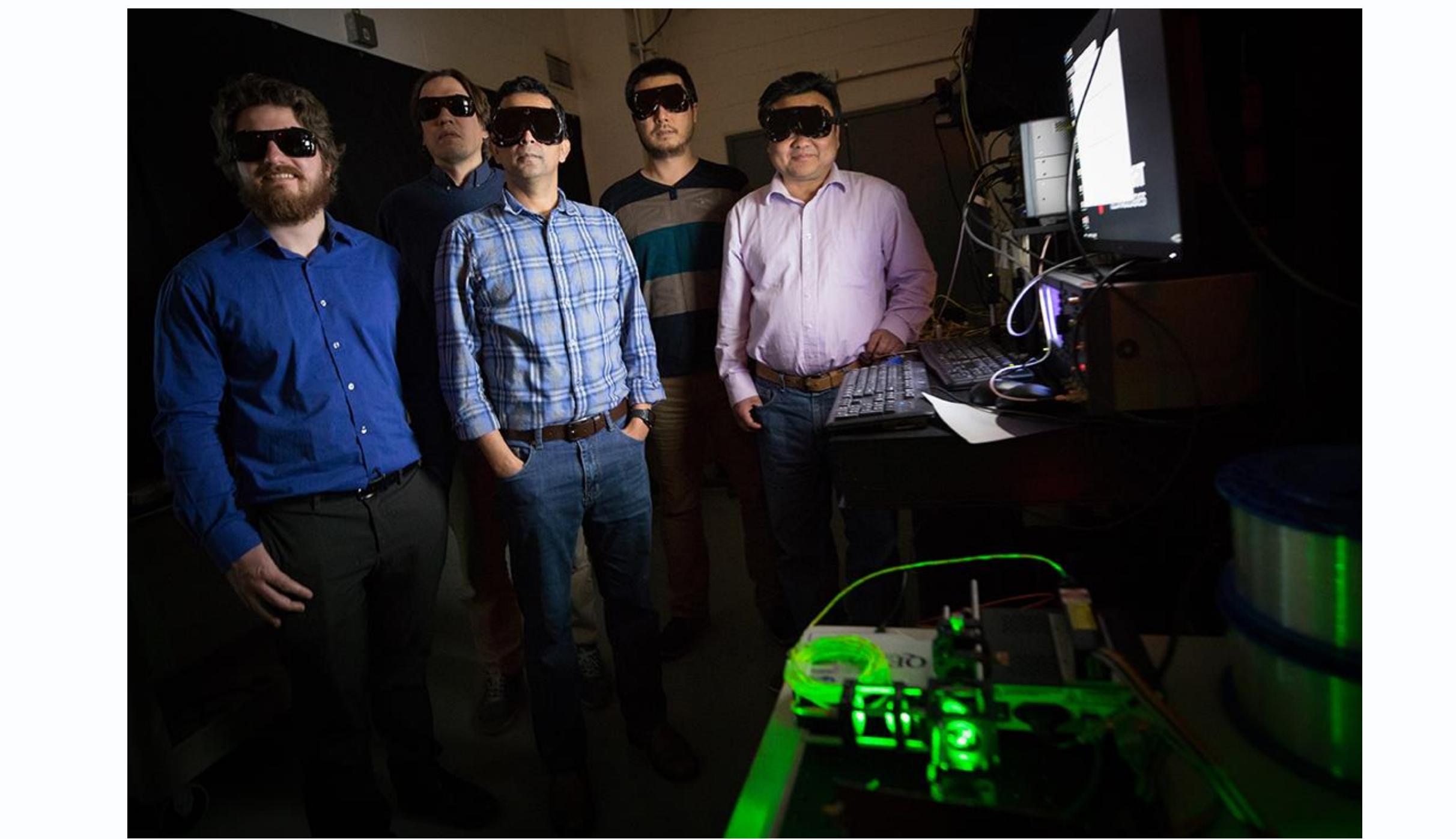


Spoof Plasmons for Enhanced ND Emission

Microwave interactions are crucial for many quantum experiments, but the weak spontaneous emission of quantum emitters makes implementation challenging. Here, significant emission enhancement (up to 10^{11}) using microwave spoof plasmon (SPP) waveguides is demonstrated.



The Team



L to R: Dr. Scott Crawford, Dr. Roman Shugayev, Dr. Hari Paudel, Dr. Ping Lu, and Dr. Yuhua Duan

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