



AQuSeND

advanced quantum sensing with nanodiamonds



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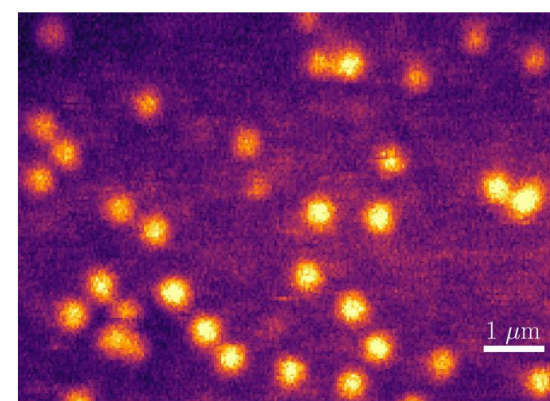
AQuSeND is moving diamond quantum sensing: from optimized materials and robust quantum control towards integrated devices and real-time measurements in complex physical and biological environments. Here, we present selected AQuSeND results from 2024–2026.

ENGINEER

Better diamond quantum sensors

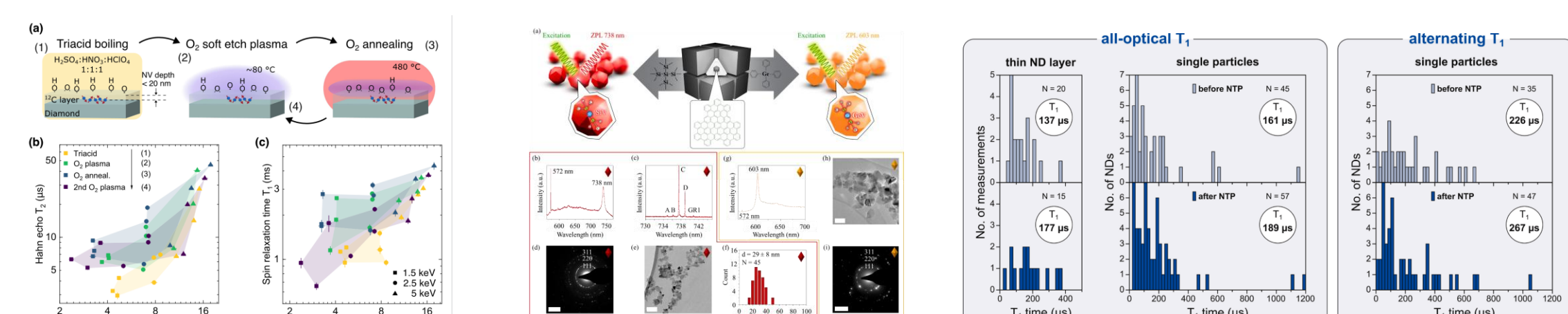
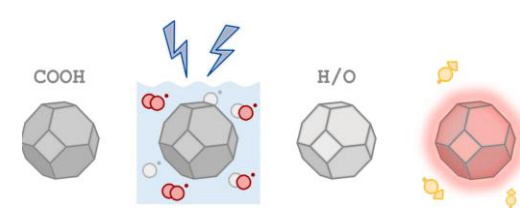
Optimized single-NV sensing [1]

Optimized optical excitation improves initialization and readout of individual NV centers, providing a reproducible platform for sensing in complex optical and microfluidic environments.



Engineering & understanding (nano)diamond properties [2-6]

Optical, spin, and surface properties determine ND sensor performance. AQuSeND investigates the role of NV concentration, defect landscape and surface termination to optimize ND sensors.

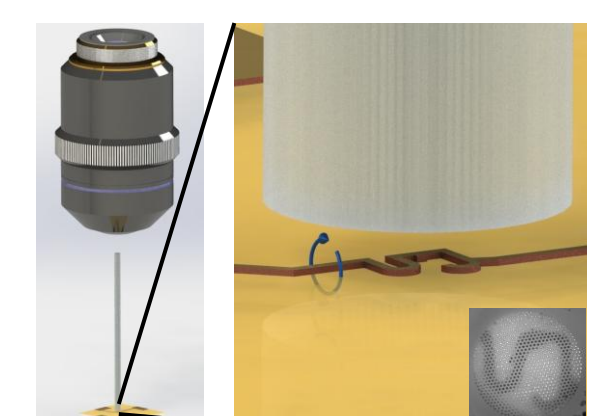


INTEGRATE

Bringing quantum sensors into devices

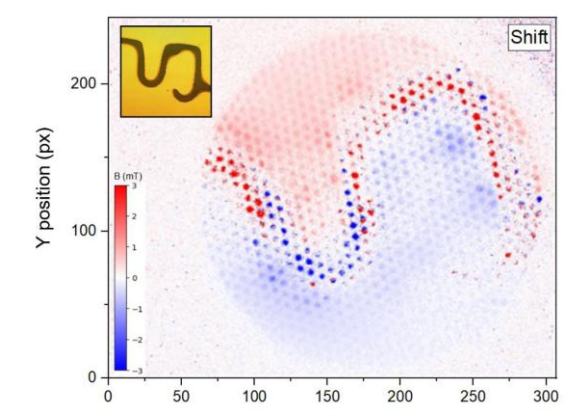
Magnetic-field endoscopy

Nanodiamond-coated imaging fiber bundles enable remote, spatially resolved magnetic-field mapping in confined and optically inaccessible environments.



Distributed fiber sensing

Embedding diamond sensors into optical fibers enables distributed ODMR sensing and spatial localization of magnetic perturbations along the fiber.

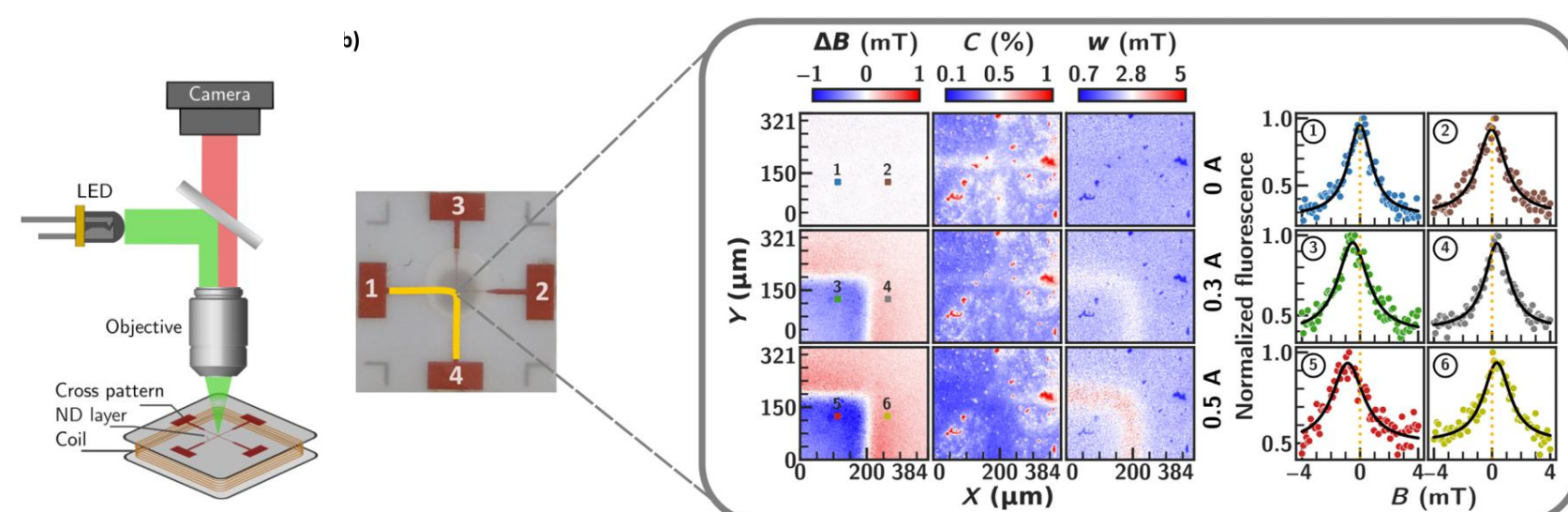


CONTROL

Robust quantum sensing protocols

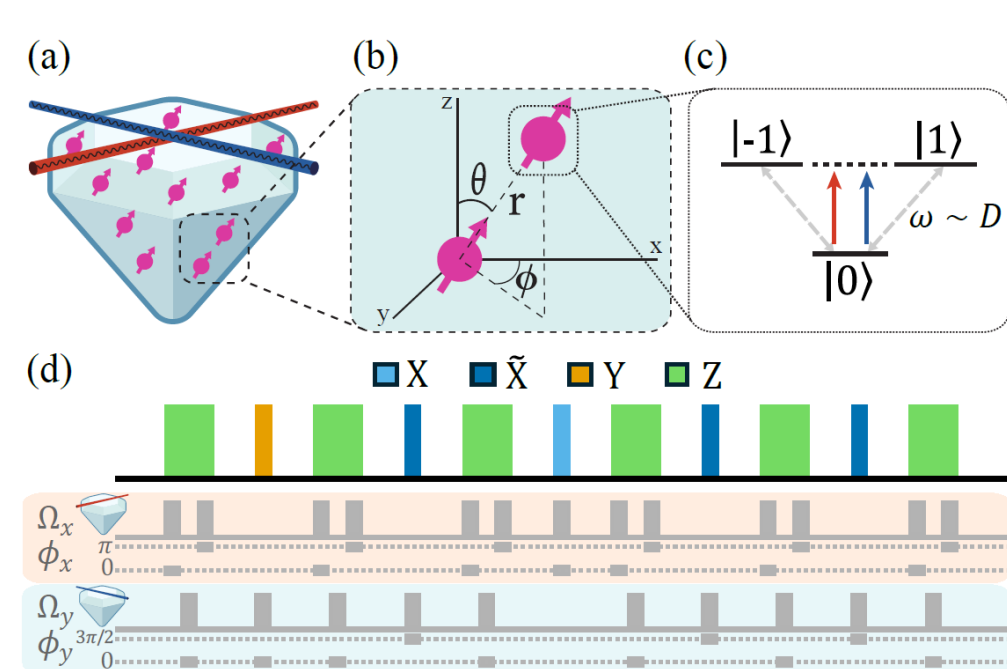
Microwave-free magnetometry [7]

Near-zero-field cross-relaxation enables magnetic imaging with NV nanodiamonds without microwave excitation, simplifying sensing in constrained environments.



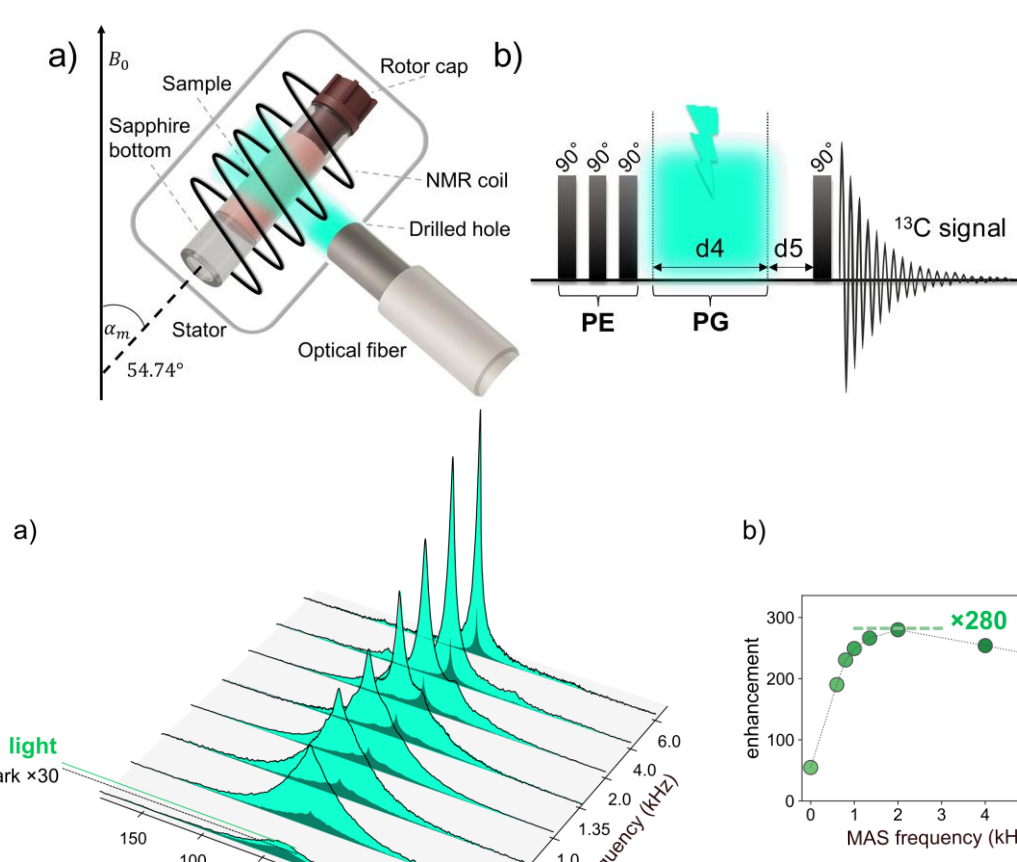
Zero-field Ensemble Neutralization via Interleaved Trilevel Handling (ZENITH) [8]

The developed protocol suppresses dipolar interactions in dense NV ensembles at zero bias field while preserving sensitivity to DC magnetic signals.



Microwave-free ¹³C hyperpolarization of Diamond Particles Enabled by Magic Angle Spinning and NV Centers [9,10]

NV-based ¹³C hyperpolarization has been demonstrated in micro- and nanodiamonds, while a microwave-free MAS approach provides orientation-robust polarization transfer with enhancements up to 411×.



Further theoretical developments address heat and current fluctuations in strongly coupled open quantum systems.[11,12]

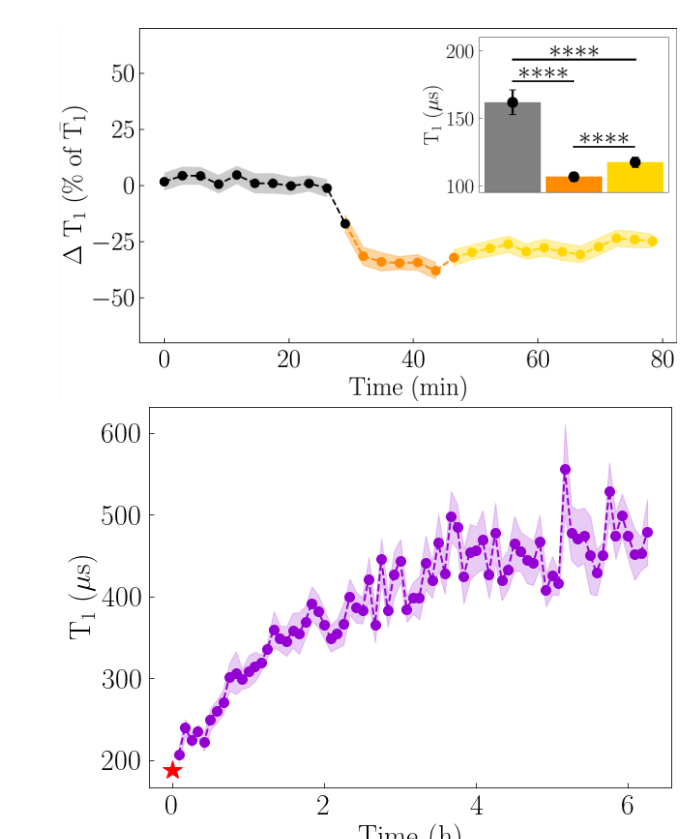
SENSE

From quantum sensors to real environments

Real-time nanoscale relaxometry

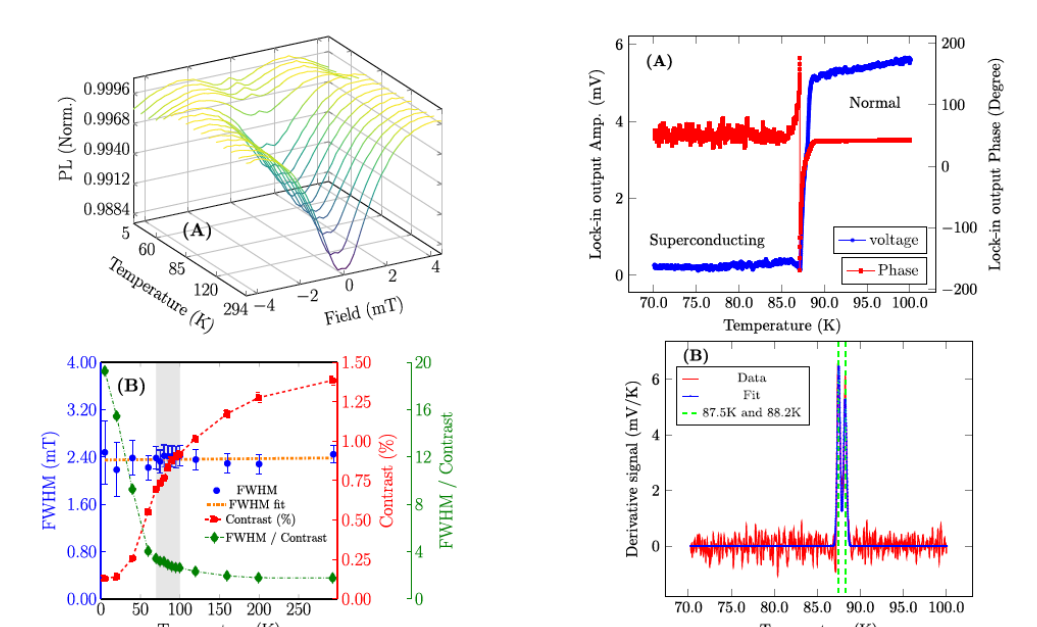
Continuous T₁ relaxometry turns NDs into real-time probes of their local environment:

- chemical sensing: 1 μM Gd³⁺ produces clearly distinguishable T₁ regimes.
- sensor dynamics: continuous T₁ monitoring reveals gradual recovery of T₁ in 40 nm NDs after surface contamination.



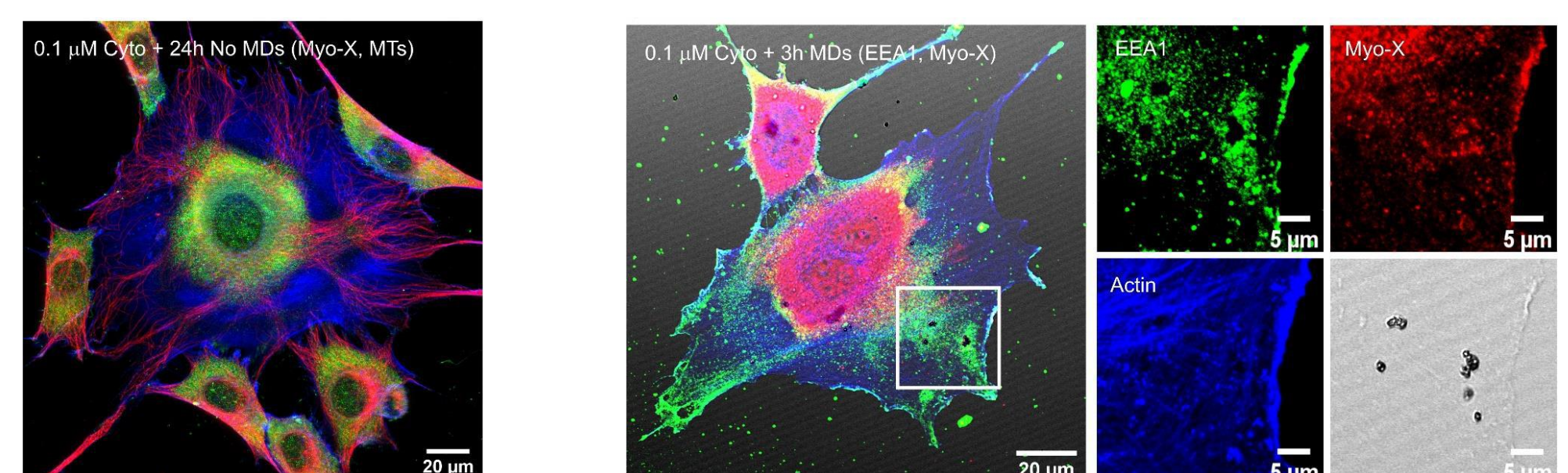
All-optical sensing of superconductivity [13]

Microwave-free nanodiamond magnetometry detects magnetic-field changes across the superconducting transition of YBCO, demonstrating sensing in a technologically relevant material system.



Towards biological quantum sensing [14,15]

Understanding cellular uptake and intracellular processing of diamond particles provides the biological foundation for future intracellular quantum sensing. Confocal imaging reveals particle-associated localization of Myo-X, EEA1 and tubulin-related signals, and their response to cytoskeletal perturbation



Selected AQuSeND publications:

- A. Martínez-Méndez et al., J. Appl. Phys. 139, 051101 (2026)
- W. Talik et al., Opt. Express 33, 13748 (2025)
- W. Talik et al., Sci. Rep. 16, DOI: 10.1038/s41598-026-66816-3 (2026)
- J. Fuhrmann et al., Mater. Quantum Technol. 4, 041001 (2024)
- M. Gulka et al., Carbon 224, 119062 (2024)
- J. Liang et al., Nature 655, 102 (2026)
- S. Sengottuvel et al., Phys. Rev. Appl. 23, 034001 (2025)
- A. Verdú et al., arXiv:2605.26863 (2026)
- R. Blinder et al., Sci. Adv. 11, eadq6836 (2025)
- R. Blinder et al., arXiv:2609.07653 (2026)
- S. P. Mandal et al., Phys. Rev. Res. 8, 013321 (2026)
- K. Mahadeviya et al., arXiv:2510.14926 (2025)
- O. Dhungel et al., Measurement 283, 122080 (2026)
- A. M. Ebrahimi et al., Commun. Biol. 7, 318 (2024)
- A. M. Ebrahimi et al., submitted to Biochem. Biophys. Res. Commun. (2026).



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