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Confocal microscopy in a controlled atmosphere for nano-scale nuclear magnetic resonance spectroscopy

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Nitrogen-vacancy (NV) centers in diamond can be used as quantum sensors with various applications, such as nano-scale NMR spectroscopy thanks to its magnetic field sensitivity. Interaction between NV centers and external spins (on the diamond surface) allows to use the former for initialization, control, and read-out of potential qubits. It has been proposed to use the latter to implement a quantum simulator on a diamond surface with shallowly implanted NV centers1. A monolayer of a 2D material could be one possible realization of such quantum simulator. A flake of black phosphorus is an ideal candidate due to the 100 % natural abundance of 31P isotope (nuclear spin I = ½) and its large gyromagnetic ratio (γ = 1.73 kHz/G), which does not overlap with other ubiquitous nuclear spins like protons and 13C. The main disadvantage of this material is that it degrades under ambient conditions. In order to resolve this, we present a confocal microscope with a glovebox enclosure for performing NV-based NMR spectroscopy in inert gas atmosphere. We perform confocal microscopy imaging and optically detected magnetic resonance in controlled magnetic field on several layers of black phosphorus. This setup could be useful to study other oxygen sensitive molecules and 2D materials that alter their properties upon exposure to air or moisture.

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