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Towards microwave imaging of single two-level defects in dielectric materials SEBASTIAN DE GRAAF, National Physical Laboratory, Teddington, United Kingdom, ANDREY DANILOV, Chalmers University of Technology, Department of Microtechnology and Nanoscience, Gothenburg, Sweden, ALEXANDER TZALENCHUK, National Physical Laboratory, Teddington, United Kingdom, SERGEY KUBATKIN, Chalmers University of Technology, Department of Microtechnology and Nanoscience, Gothenburg, Sweden — Two-level fluctuators (TLF) are a major source of decoherence in quantum devices and significant effort is invested towards better understanding and eliminating these types of material defects. Here we propose that a near-field scanning microwave microscope (NSMM) can be used to image individual two-level defects on the nano-scale, provided that such a microscope operates in the right regime [1]. Not only would such a coherent NSMM be able to obtain nano-scale spatial distributions of defects and their locations within dielectric materials, it would also be able to determine the relative orientation of the TLF dipole with respect to the dielectric crystal, giving vital information about the nature of the TLF. We theoretically describe the operation and capabilities of a coherent NSMM and show that individual defects can be imaged in dielectric materials with low enough loss tangent, such as sapphire and silicon dioxide, relevant for solid state quantum technologies. We describe the requirements for constructing such an NSMM and report on our recent progress in setting up this technology [2]. [1] S. E. de Graaf, et al., Sci. Rep., in press (2015). [2] S. E. de Graaf, et al., Rev. Sci. Instrum. 84, 023706 (2013).

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