RydEx 2024, Dortmund, Germany

Optical-to-microwave frequency conversion with Rydberg excitons

D. Ziemkiewicz[1]

Institute of Mathematics and Physics, Technical University of Bydgoszcz,
Al. Prof. S. Kaliskiego 7, 85-789 Bydgoszcz, Poland
**e-mail: david.ziemkiewicz@pbs.edu.pl*

The process of optical frequency conversion provides a fundamental and important approach to modify light. Possibilities of manipulating the frequency without changing the information of other degrees of freedom of light will enable one to establish an interface between various optical systems operating in different frequency regions and have many classical and quantum applications [1]. A variety of quantum qubit systems exploiting excitations at optical frequencies or superconducting qubits operating at microwave frequencies have been described and practically applied [2]. The first step toward many microwave applications is an efficient conversion of energy from optical frequencies to microwave ones. We propose a conversion scheme that is a solid-state analogue of Rydberg states of atoms placed in a cavity, basing on the recent observations of interactions involving coupling of REs with microwaves in Cu2O [3].

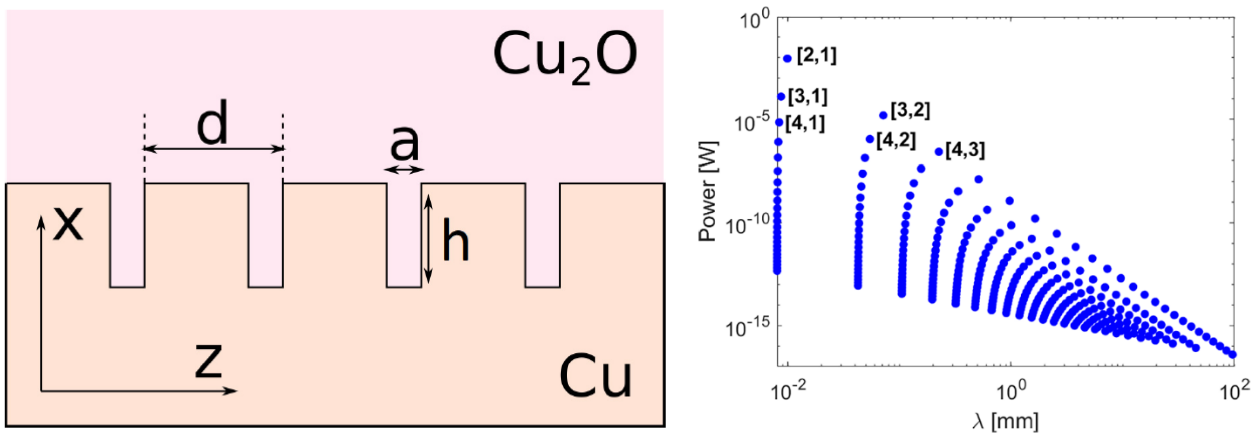

Fig. 1. a) Schematic representation of the system. b) emission power as a function of wavelength and excitonic states used in conversion.

References

[1] X. Han, W. Fu, C. Zou, L. Jiang, and H. X. Tang, Microwave-optical quantum frequency conversion, Optica **8**, 1050 (2021).

[2] N. J. Lambert, A. Rueda, F. Sedlmeir, and H. G. L. Schwefel, Coherent conversion between microwave and optical photons - An overview of physical implementations, Adv. Quantum Technol. **3**, 1900077 (2020).

[3] L. A. P. Gallagher, J. P. Rogers, J. D. Pritchett, R. A. Mistry, D. Pizzey, C. S. Adams, and M. P. A. Jones, Microwave-optical coupling via Rydberg excitons in cuprous oxide, Phys. Rev. Res. **4**, 013031 (2022)