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Industrial microfabrication of 2D and 3D ion traps for quantum information processing

To realize a useful quantum computer based on trapped ions, scaling the number of ions is an important requirement. However, scaling up to several hundreds or thousands of ions while maintaining sufficient qubit fidelity implies complex trap designs that can only be achieved by first-class industrial manufacturing. Fabrication in a productive fab offers a precise process control as well as numerous in-line measurement options to guarantee high reliability and reproducibility of the ion trap devices.
Based on standard semiconductor manufacturing processes including MEMS technologies, various ion trap designs such as 2D ion trap arrays [1] and 3D trap architectures [2] have already been produced at the industrial cleanroom facilities of Infineon Technologies. These were subsequently tested in experiments at the collaborating academic partners University of Innsbruck and ETH Zurich.
I will give an overview of the fabrication capabilities at Infineon to fabricate 2D and 3D ion traps based on silicon and fused silica substrate, comprising multiple metal layers for complex and scalable designs. In addition, measurement results of electrical properties, heating rates and stray fields will be presented to verify the functionality of these traps and to show the promising potential of an industrial manufacturing to realize scalable ion traps.

[1] P. Holz, S. Auchter et al., Adv. Quantum Technol. 3, 2000031 (2020)
[2] S. Auchter, C. Axline at al., Quantum Sci. Technol. 7, 035015 (2022)

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