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Pushing STED-inspired laser lithography towards industrial metrology

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With confocal microscopes, white light interferometers and focus variation measuring devices, the areal optical measurement technique can no longer be discarded from the industrial characterization of component surfaces. Since December 2019, the metrological characteristics for the calibration of these devices are published as part 600 from the ISO 25178 series [1], in addition to the previously standardized calibration geometries within part 70 [2]. The demands on these standardized specimens for an ISO-compliant calibration of the aforementioned devices are enormously high. Currently, one of the very few technologies fulfilling these high demands in an application-oriented way can be found in Two-Photon laser lithography (2PLL), alias direct laser writing [3]. It allows for the manufacturing of a so-called universal calibration artefact for an overall calibration of measuring devices with one single sample [4].

Regarding the ongoing improvement of measuring instruments, sufficient high-resolution calibration specimens have to be available in future, too. In order to guarantee this, the concept of stimulated emission depletion (STED) [5,6], which is well known and established in microscopy for resolution enhancement, is also used in laser lithography here [7].

This scientific talk will outline the development process of this STED-inspired additive manufacturing technology from the basic physical-technical principles to the characterization of the fabricated calibration specimen and their (industrial) application. Optical, photonic and chemical processes both, during and subsequent to the manufacturing process, as well as the algorithmic and technological improvement of this technology play a decisive role. Additionally, a general overview of the different fields of research using Two-Photon laser lithography shall be given.

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Fig. 1: 3D µ-printed universal calibration artifact.

Fig. 2: Simulated laser focus superposition for STED-inspired 2PLL.