Advanced Maskless Grayscale Lithography using a new writing strategy to increase the number of grayscale levels

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Maskless Grayscale Lithography is the state of the art technology for rapid prototyping of micro optics. The current technology is mainly limited by the number of grayscale levels, which is typically 256.
As the demand for thicker structures with a broad range of structure sizes increases, the number of grayscale levels restrict the smoothness of resist profiles, resulting in visible, undesired steps. Steps on the surface of a micro lens can create unacceptable diffraction pattern. A long tapered wave may have steps where a smooth slope would be expected.
In order to overcome this problem we developed a new writing method based on a Maskless Lithography (DWL66FS) system to increase the number of grayscale levels without modifying the hardware.
The standard DWL66FS grayscale writing method uses overlapping stripes to reduce stitching irregularities at the stripe connection in thick photo resists. For the new writing strategy we enhanced this principle to create intermediate gray levels by interpolation. The result is a drastical increase of possible grayscale levels. With this method there is theoretically no limitation to the number of levels.
In this work we compare the grayscale performance of a standard grayscale method and the new advanced grayscale principle with 10 times more grayscale levels. We will show that the new writing principle allows a very fine control of the depth especially in the upper area of the photo resist. As a result, steps in long slopes disappear. Large micro lenses do not present diffraction steps, and the surface of structures is much smoother. Furthermore, the increased number of grayscale levels could be used to compensate for nonlearities in the photoresist response curve for complex patterns such as fresnel lenses.