Fabrication of high resolution computer-generated holograms using 3D electron beam lithography

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This paper describes development of 3D electron beam lithography process using MicroChem low contrast PMMA A50 resist[1] and Raith 150 TWO EBL system[2] to fabricate a high resolution hologram fringe pattern. Holographic fringe patterns are usually stamped or printed with pixel sizes on the 1-2 micron scale using printing techniques based on optical lithography. These methods are inherently limited to these scales. Towards achieving artistically sharper and clearer reconstructed holograms, fringe patterns are written using electron beam lithography in a polymer resist, with pixel resolution down to 200 nm × 200 nm. Initial tests are to develop a process for a 9-level (3-bit) interference pattern in a low contrast polymer e-beam resist 450 nm thick (each level is 50 nm). A sinusoid test pattern was written to establish the e-beam doses for each 50 nm level, as shown in Figure 1(a). These doses were then used to fabricate a 5000 × 5000 pixel test pattern, as shown in Figures 1(b)-(d). Investigations are currently underway to scale-up to larger write fields.

[1] MicroChem Corp., 90 Oak St, Newton, MA 02464, USA.

[2] Raith GmbH, Konrad-Adenauer-Allee 8 - Technologiestandort Phoenix West 44263 Dortmund, Germany.

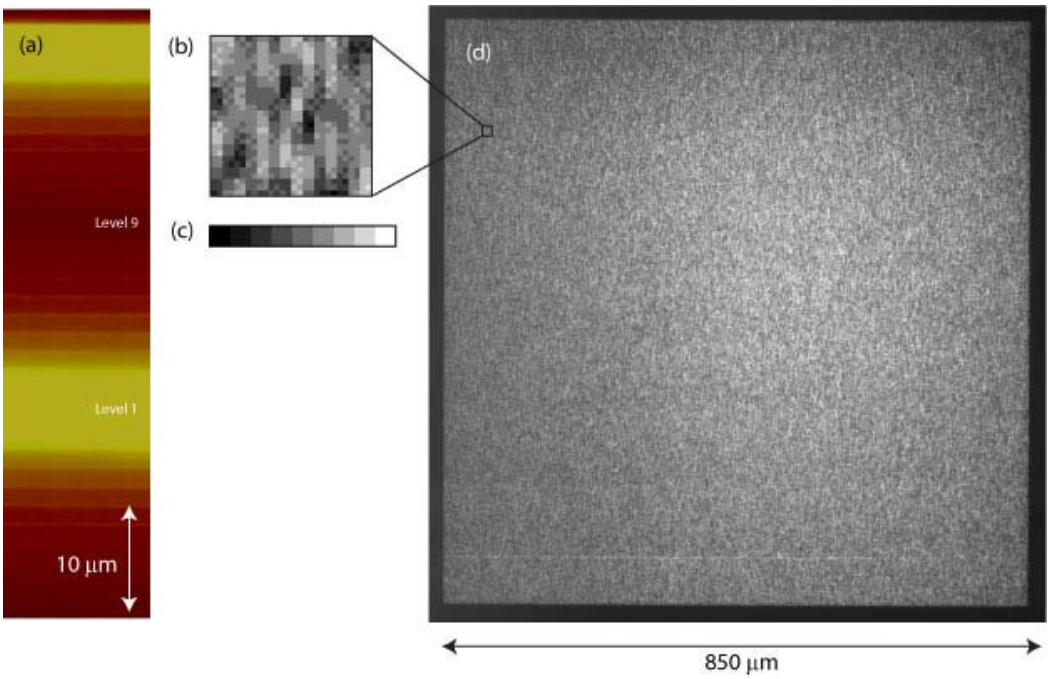

Figure 1: (a) AFM profile demonstrating 9-level sinusoid test pattern. (b) Computer generated hologram fringe pattern in 9-level grayscale and (c) corresponding 9-level grayscale map. (d) Optical micrograph of EBL written PMMA test structure.