Large area diffraction gratings for augmented reality surface relief waveguide masters

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To meet the demand for high quality augmented reality displays with larger field of view, large eye box and better image quality, large area diffraction gratings are needed. Across the industry different types of surface relief gratings for in-coupling and out-coupling are used in the waveguide designs to achieve the optimum performance of the waveguide. Typical gratings are slanted, blazed, binary and multi-level gratings. NIL Technology offers solutions for all of the above-mentioned types of gratings meeting the demand for high quality and size of in particular the output gratings from the market. The fabrication processes allow for complete design freedom to combine all types of gratings at any given placement and orientations.

Blazed gratings with pitches from 150 nm and up, with blaze angles from 10 to 50 degrees and very small anti blaze has been demonstrated, Figure 1 shows an example of a blazed grating. The fabrication technique ensures low surface roughness and high control of all design parameters.

Slanted gratings demonstrated by NIL Technology have high slant planarity, sharp corners and horizontal top and bottom planes, Figure 2 shows an example of a slanted grating.

Binary and multi-level gratings are typically used for out-coupling gratings, Figure 3 shows and example of a large area binary grating. Typical sizes are up to 15 cm^2 for the AR displays with the largest field of view. These gratings are made with no visual stitch lines and a max error in pitch of 20 pm. The depth uniformity is better than 5% across the gratings. Figure 4 shows schematics of a typical high level master layout and Figure 5 an example of real device.

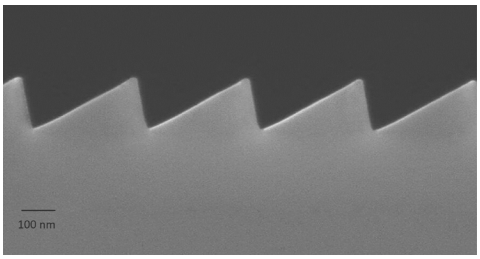

Figure 1. Blazed grating master with 325 nm pitch, 25 nm antiblaze and 30 degrees blazed angle.

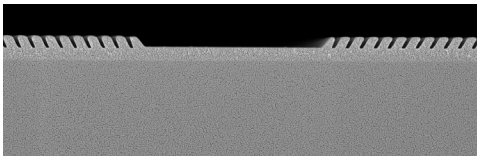

Figure 2. An example of a slanted grating master with 700 nm pitch and 45.5 degrees blazed angle

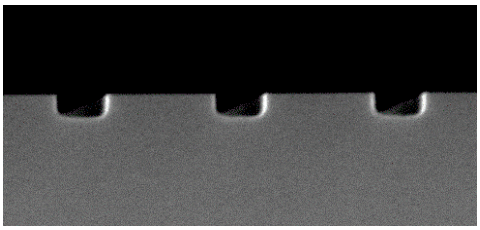

Figure 3. Cross section of large area binary grating.

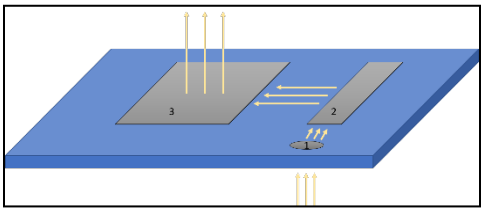

Figure 4. (1) IG (in-coupling grating) – typically blazed or slanted in mm^2. (2) OG1 (out-coupling or expander) – typically binary or slanted in cm^2. (3) OG2 (out-coupling eye box) – typically binary or slanted in cm^2.

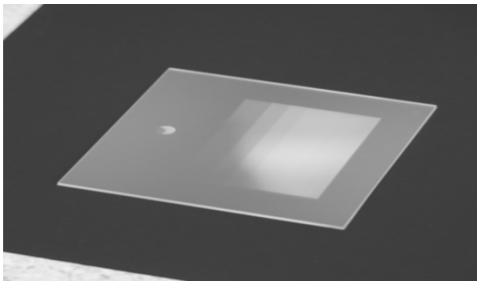

Figure 5. An example of real device and a representative example of waveguides