Supplementary Material

Double-groove rectangular gratings for high-efficiency wideband vertical coupling in planar-integrated optical systems

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Tolerance Analysis

In the manufacturing process of the grating coupler, the actual shape of the grating structure always deviates from optimized parameters because of various fabrication errors, resulting in the deterioration in performances, such as coupling efficiency, and light noises at other undesired orders of the grating coupler. Therefore, it is necessary to assess the manufacturing tolerances of the grating design. In Fig. S1–Fig. S4, the several important structure parameters of the grating coupler for tolerance investigation.

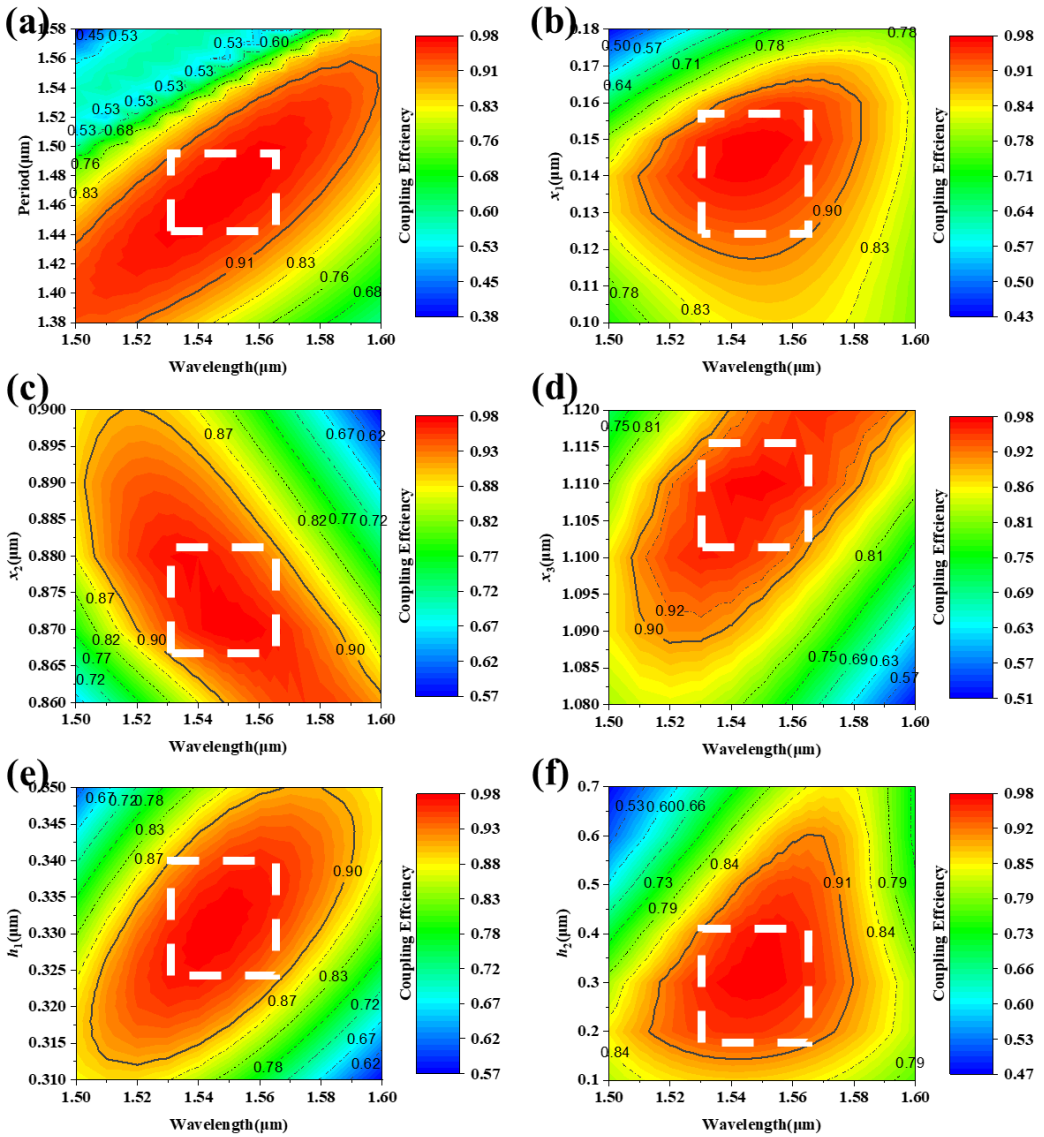

Figure S1. Numerical simulation of the tolerance analysis for structure parameters in the C band. The contour map of the coupling efficiency in (a) the grating period Λ, (b) the lateral position x_1 (c) the lateral position x_2 (d) the lateral position x_3 (e) the etching depth of the first ridge layer h_1 (f) the etching depth of the second ridge layer h_2. The broken rectangles denote the areas where the diffraction efficiency is higher than 90% in the C band.

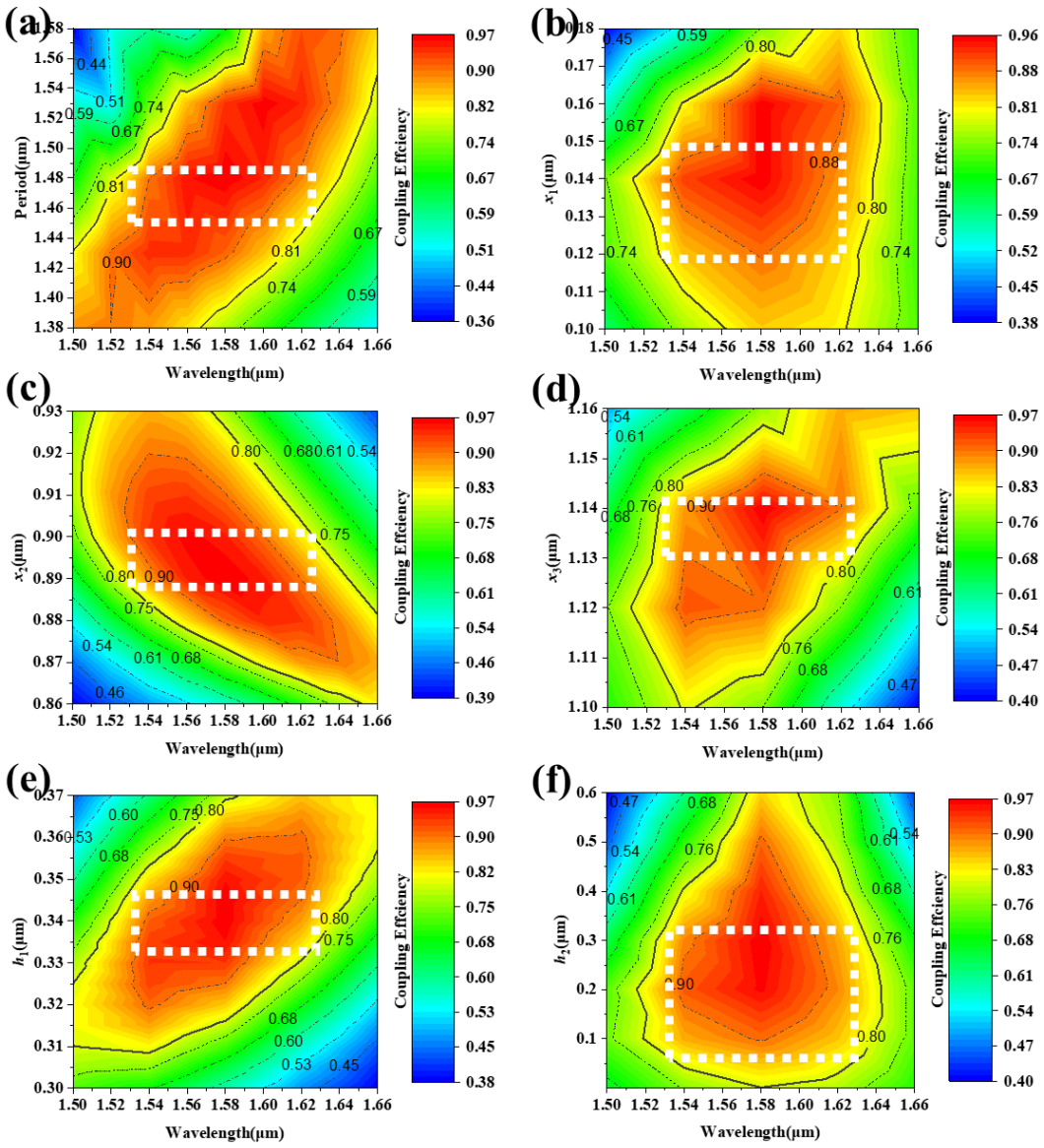

Figure S2. Numerical simulation of the tolerance analysis for structure parameters of the grating coupler designed in the C + L band. The contour map of the coupling efficiency versus (a) the grating period Λ, (b) the lateral position x1 (c) the lateral position x2 (d) the lateral position x3 (e) the etching depth of the first ridge layer h1 (f) the etching depth of the second ridge layer h2. The dot rectangles denote the areas where the diffraction efficiency is higher than 80% in the C + L band.

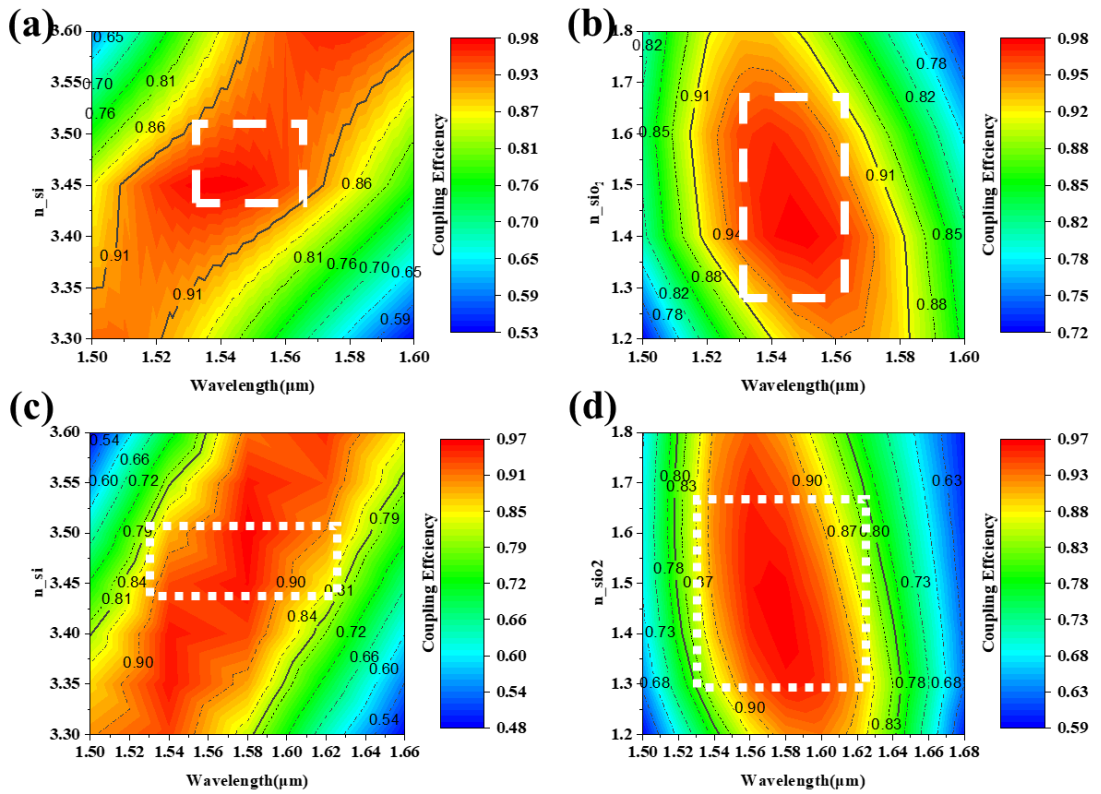

Figure S3. The tolerance analysis of the material refractive index. The influence of the refractive index of the two-layer ridges on the coupling efficiency in C and C + L bands. (a) the first layer α-Si, and (b) the second layer SiO2 in the C band; (c) the first layer α-Si, and (b) the second layer SiO2 in the C + L band. The broken and dotted rectangles denote the area where the diffraction efficiency is higher than 90% in C, and 80% in the C + L band, respectively.

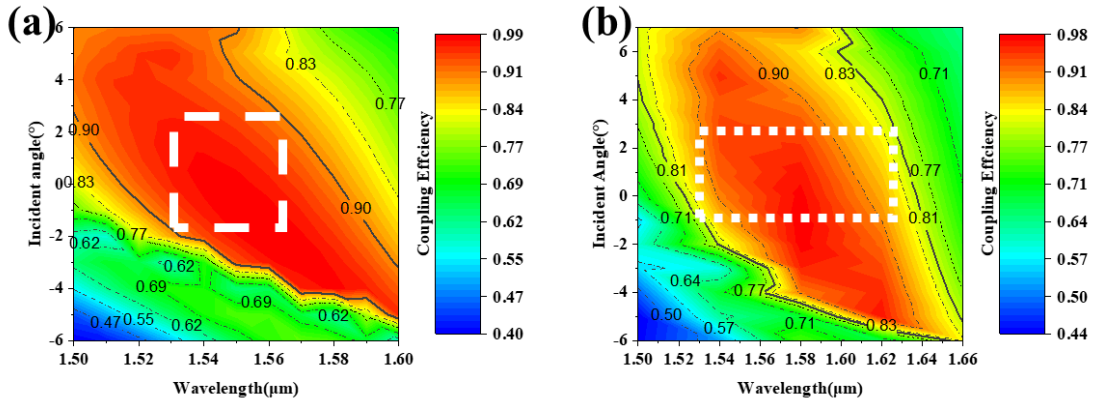

Figure S4. The tolerance analysis of incident angle in (a) C band and (b) C + L band. The broken and dotted rectangles denote the area where the diffraction efficiency is higher than 90% in the C, and 80% in the C + L band, respectively.