Results

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The simulation was conducted on 3 structures. The d1 varied from 450 to 550 nm, d2 varied from 200 to 300 nm, and from 0.5 ° to 6 °. The shifted CIS’ QE and X-talk have negative and positive 3-D quadratic relationship with d1 and d2 in the region. Also the tilted DTI CIS’ QE and X-talk have negative and positive quadratic relationship with in the region.



Fig. 1. QE on d2 (y) vs. d1 (x) in the shifted CIS.

The shifted CIS was optimized at d1 = 510 nm and d2 = 230 nm (Fig. 1). We have to tradeoff between high QE and low X-talk. The X-talk varied < 1%. Therefore, QE was given more weight.



Fig. 2. QE (y) vs. angle (x) in tilted DTI CIS. Filled circle: red, Unfilled circle: green, Square: blue, Diamond: white.

The tilted DTI CIS was optimized at (Fig. 2). We find the point at which maximum QE and minimum X-talk. The X-talk looks like constant because it varied < 1%. Therefore, we focus to find the point at which maximum QE.



Fig. 3. QE on d2 (y) vs. d1 (x) in the tilted DTI CIS at .

The tilted DTI CIS was optimized at d1 = 510 nm, d2 = 230 nm, and (Fig. 3). We fixed the for find the optimized d1 and d2.

Table 1. QE and crosstalk of CF for 3 different CIS.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **CIS Structure** | | | | | | |
|  | **CF** |  | **Base** |  | **Shifted** |  | **Tilted DTI** |  | **Increment** |
| **QE [%]** | **R** |  | 58.2 |  | 44.5 |  | 48.3 |  | 3.80 |
| **G** |  | 68.0 |  | 59 |  | 63.7 |  | 4.70 |
| **B** |  | 61.6 |  | 59.3 |  | 59.6 |  | 0.30 |
| **W** |  | 66.4 |  | 55.2 |  | 57.9 |  | 2.70 |
|  |  |  |  |  |  |  |  |  |  |
| **Crosstalk [%]** | **R** |  | 1.96 |  | 2.88 |  | 2.83 |  | -0.05 |
| **G** |  | 31.7 |  | 31.6 |  | 31.4 |  | -0.20 |
| **B** |  | 12.7 |  | 13.6 |  | 13.5 |  | -0.10 |

In compare the QE between the shifted CIS and the tilted DTI CIS, all four CF’s QE are increased (Table. 1). Also, the X-talk decreased < 0.2%.



(a)

(b)

(c)

(d)

(e)

(f)

Fig. 4. Power flow of the shifted CIS and the tilted DTI CIS. (a) red, (c) green, and (e) blue pixel of the shifted CIS. Also, (b) red, (d) green, and (f) blue pixel of the tilted DTI CIS.

The DTI led the light move to center of the CIS which the photo detector region (Fig. 4). In tilted DTI CIS, the light can be more detected. Also, it prevents the light leakage more than the shifted CIS.