CLAIMS

1. An optical waveguide unit, comprising:

at least one group of total reflection layers, each group comprising at least one type of total reflection layer, and each type of total reflection layer comprising at least one single total reflection layer; and

at least two sub-waveguides, one group being arranged between every two adjacent sub-waveguides,

wherein a number of the sub-waveguides is four, a number of the groups is three, and the groups comprise:

a first type of total reflection layer in middle; and

two second types of total reflection layers, a refractive index of the second type of total reflection layer is different from a refractive index of the first type of total reflection layer, and the two second types of total reflection layers are located on both sides of the first type of total reflection layer along a stacking direction of the group and the sub-waveguide.

2. The unit as claimed in claim 1, wherein a total height H of the optical waveguide unit satisfies 0.1mm<H<5mm along a stacking direction of the group and the sub-waveguide.

3. The unit as claimed in claim 1, wherein heights of the four sub-waveguides are GH1, GH2, GH3, GH4 in order along the stacking direction, where GH1=GH4=GH2+GH3, GH2 =GH3, GH1+GH2=GH3+GH4.

4. The unit as claimed in any one of claims 1 to 3, wherein a distribution of each total reflection layer in each type of total reflection layer in the group satisfies a formula of:

$$\mathrm{comb}(x)=\sum_{i=1}^{k}\sum_{num=1}^{m_i}\delta(x-num\cdot T_i),$$

where, $\mathrm{comb}(x)$ represents a comb function;

one side surface of the optical waveguide unit serves as a reference plane along a stacking direction of the group and the sub-waveguide, and the reference plane is perpendicular to the

stacking direction, where:

k represents a total number of types in the group;

i represents a serial number of types in the group, and is an integer;

x represents a distance from a single total reflection layer in the ith type of total reflection layer to the reference plane;

num represents a serial number of the single total reflection layer in the ith type of total reflection layer;

m_i represents a total number of total reflection layers in the ith type of total reflection layer;

T_i represents a position period of the ith type of total reflection layer, and the position period is a shortest distance that adjacent appearances of the ith type of total reflection layer in the optical waveguide unit; and

$\delta(x)$ represents a pulse function.

5. The unit as claimed in claim 4, wherein the position period T_i is calculated by a formula of:

$$T_i = W \cdot \tan(\arcsin(\sin(\theta_i)/n))/\sqrt{2},$$

where, W represents a width of a cross section of the optical waveguide unit, a direction of the width on the cross section is perpendicular to the stacking direction;

θ_i represents an incident angle corresponding to the ith type of total reflection layer on a surface of the optical waveguide unit; and

n represents a refractive index of the sub-waveguide.

6. The unit as claimed in claim 4 or 5, wherein a thickness of each layer in each type of total reflection layer is $0.04\ mm<t<0.2T_i$.

7. The unit as claimed in any one of claims 3 to 6, wherein a refractive index range n_{ei} of each type of total reflection layer is calculated by a formula of:

$$n_{ei} = \sqrt{n^2 - 0.5 \cdot \sin(\theta_i)^2}$$

where, θ_i represents a predetermined angle selected within a viewing angle range, and n represents a refractive index of the sub-waveguide, and n>1.4.

8. The unit as claimed in any one of claims 1 to 7, wherein both sides of the optical waveguide unit are provided with reflection layers along a stacking direction of the group and the sub-waveguide.

9. An optical waveguide array comprising:

a plurality of optical waveguide units according to any one of claims 1 to 8, each optical waveguide unit having a rectangular cross section, and the plurality of optical waveguide units being joined in parallel;

an outer contour of the optical waveguide array is rectangular, and an extending direction of the optical waveguide units and at least two sides of the outer contour of the optical waveguide array form an angle of 30 to 60 degrees.

10. The array as claimed in claim 9, wherein the extending direction of the optical waveguide units and the at least two sides of the outer contour of the optical waveguide array form an angle of 45 degrees.

11. The array as claimed in claim 9 or 10, wherein the plurality of optical waveguide units are joined through an adhesive layer, and a thickness of the adhesive layer is more than 0.001 mm.

12. A flat lens, comprising:

two transparent substrates, each transparent substrate having two optical surfaces; and

two optical waveguide arrays according to any one of claims 9 to 11, the two optical waveguide arrays being arranged between the two transparent substrates by means of glue, and optical waveguide extending directions of the two optical waveguide arrays being arranged

orthogonally.

13. The lens as claimed in claim 12, wherein an optical surface of each transparent substrate far away from the optical waveguide array is provided with an antireflection film.