

# Integrated Photonics

## Figures and Images for Instructors

### Module 1

## Photonic Integrated Circuits Materials and Fabrication Technologies

Optics and Photonics Series



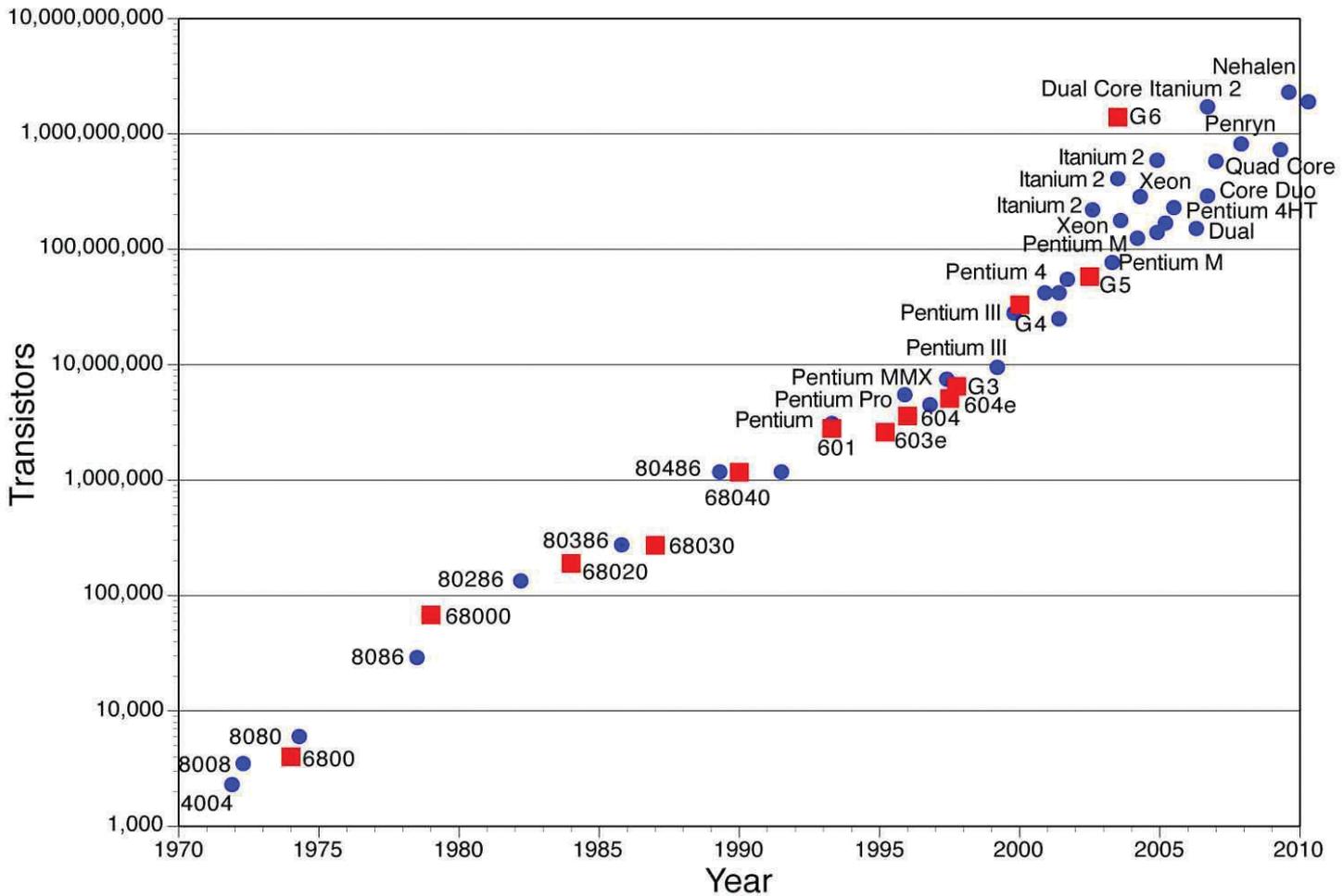
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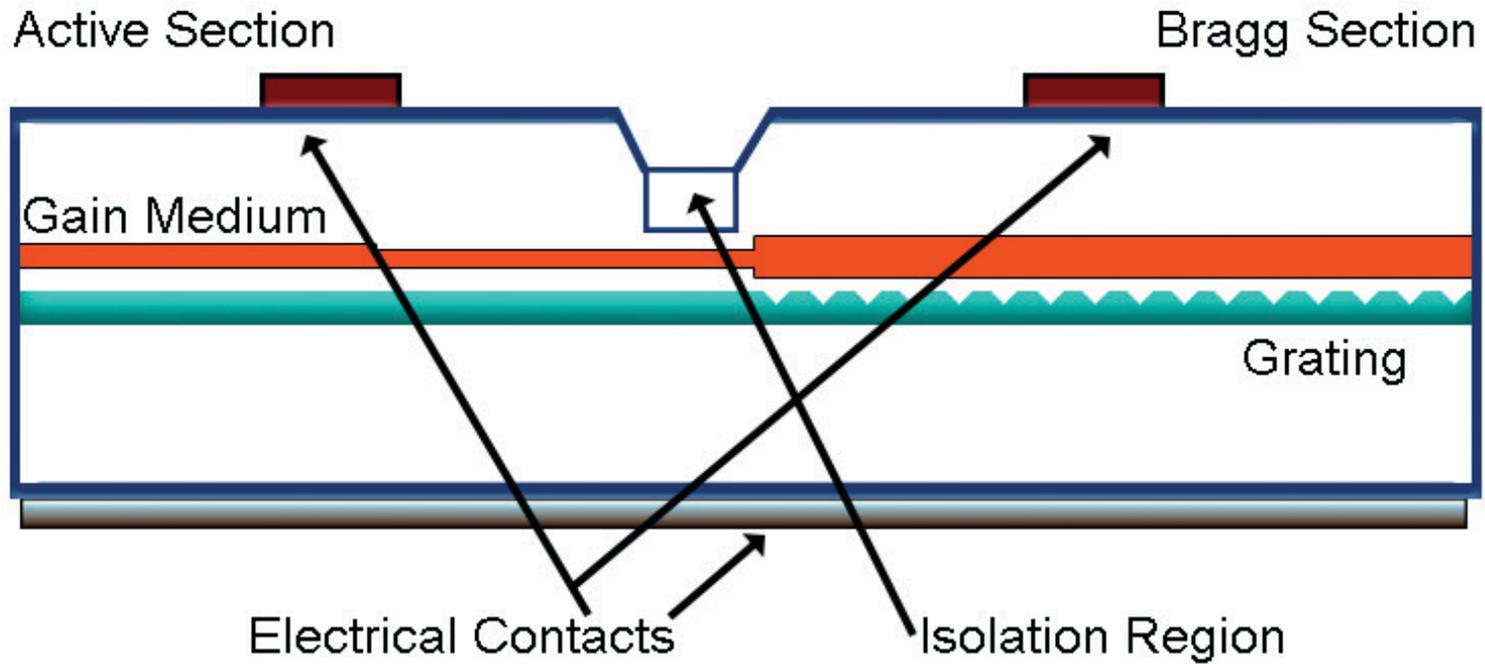
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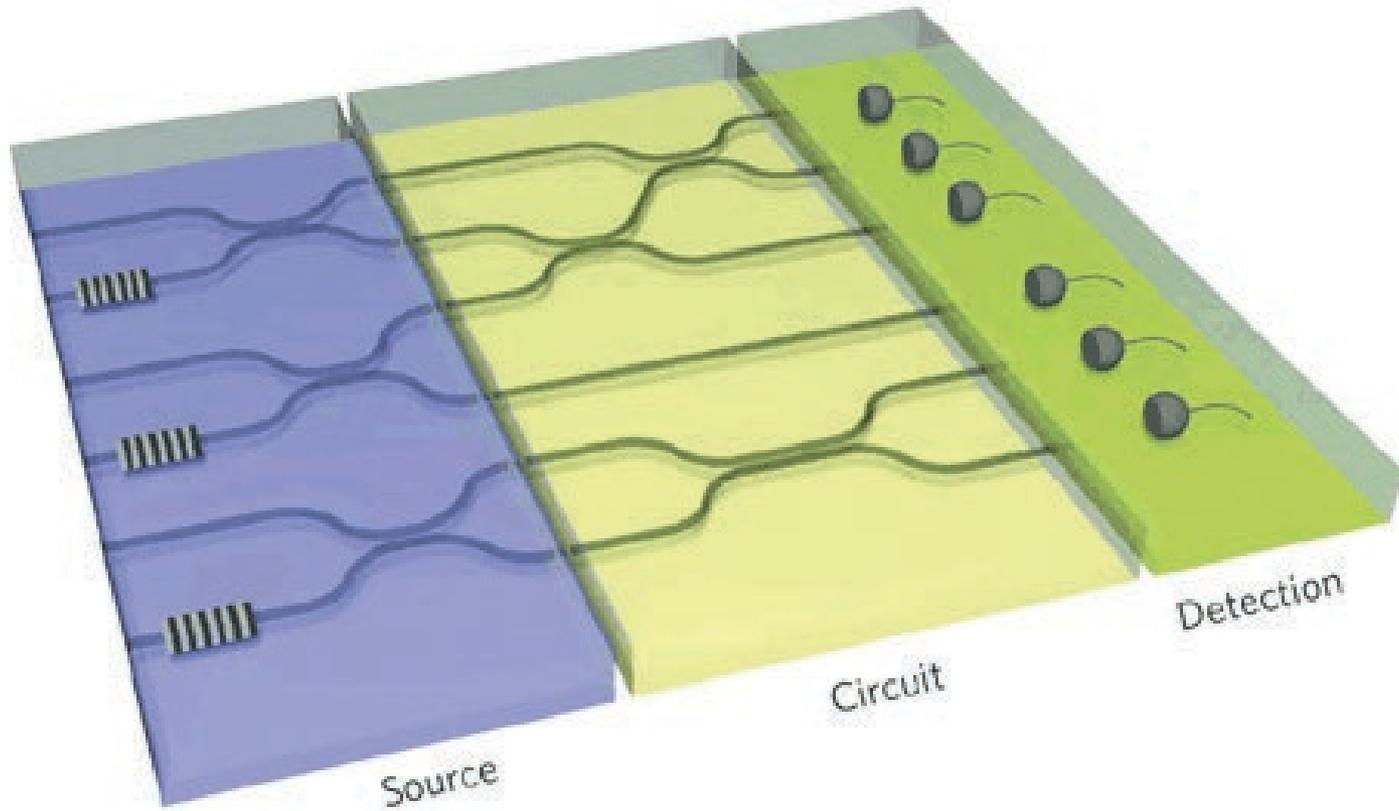
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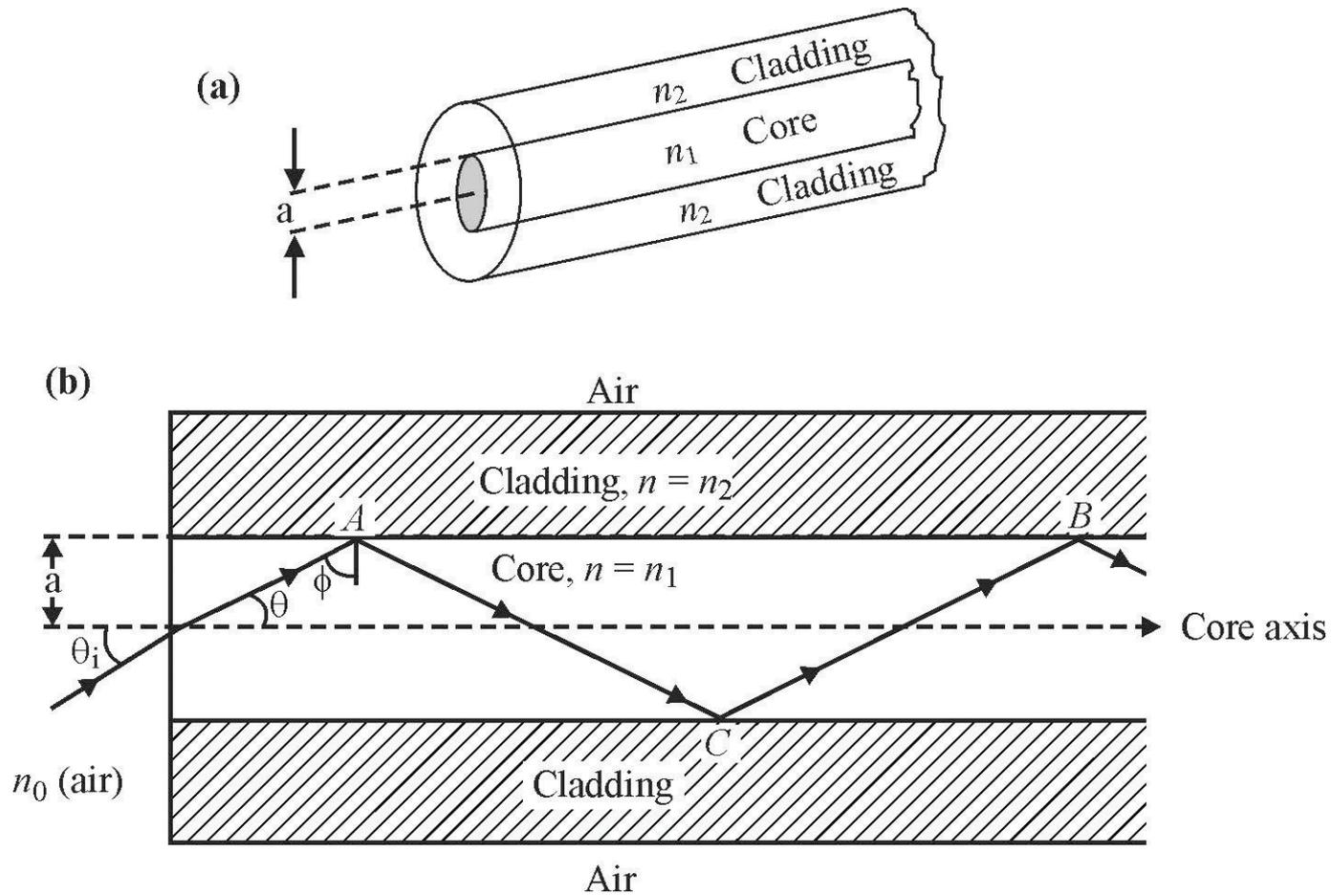
**Figure 1-1** *Illustration of Moore's law, which predicts that the number of transistors in a microprocessor chip doubles every two years*



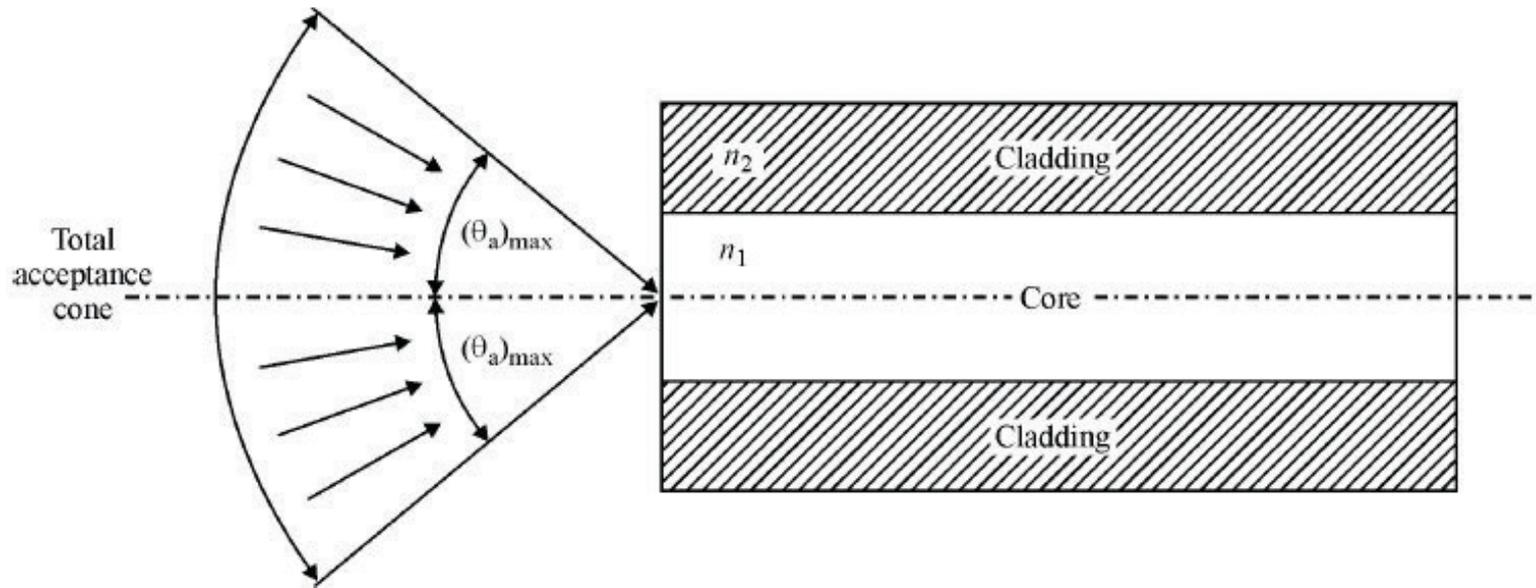
**Figure 1-2** *Illustration of distributed Bragg reflector semiconductor laser. The active section and the grating sections serving as mirrors are integrated in the same structure.*



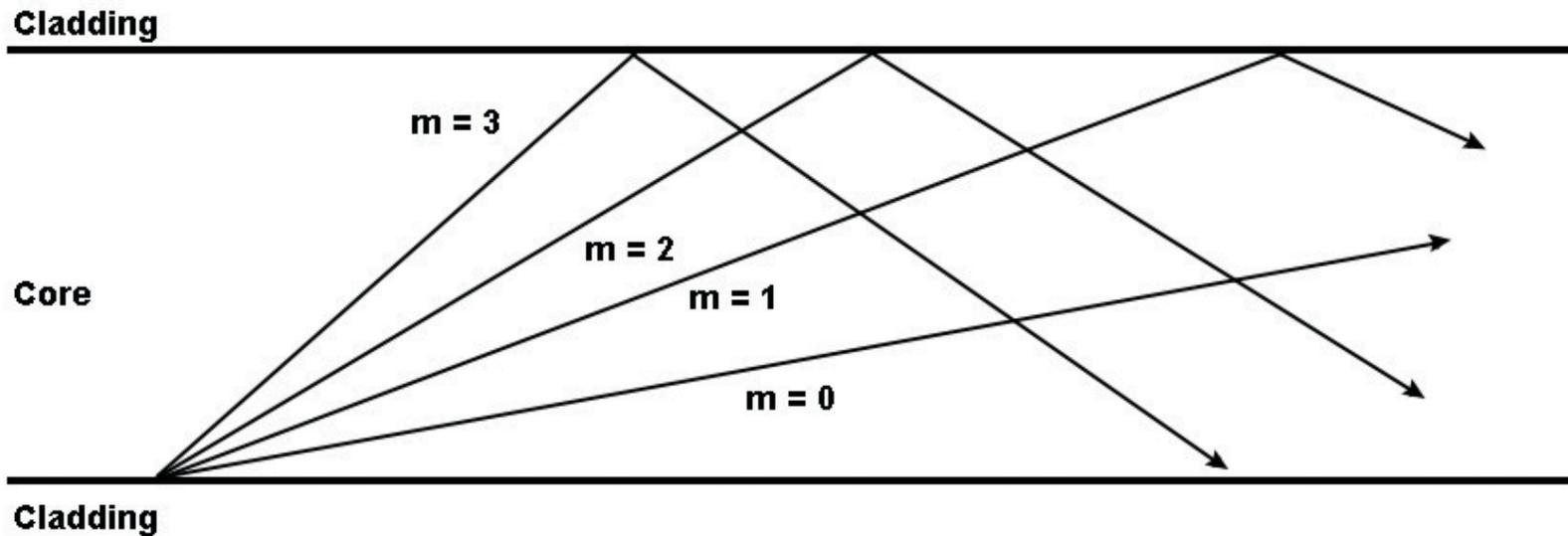
**Figure 1-3** *PIC integrating optical sources, a routing circuit, and photodetectors*



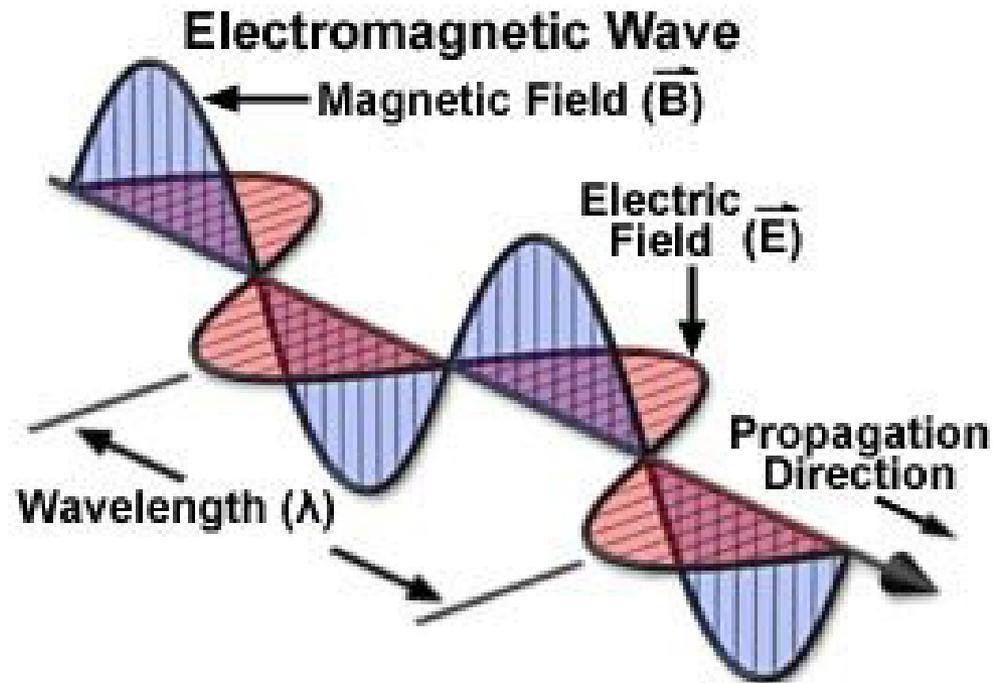
**Figure 1-4** *Fiber Geometry*+



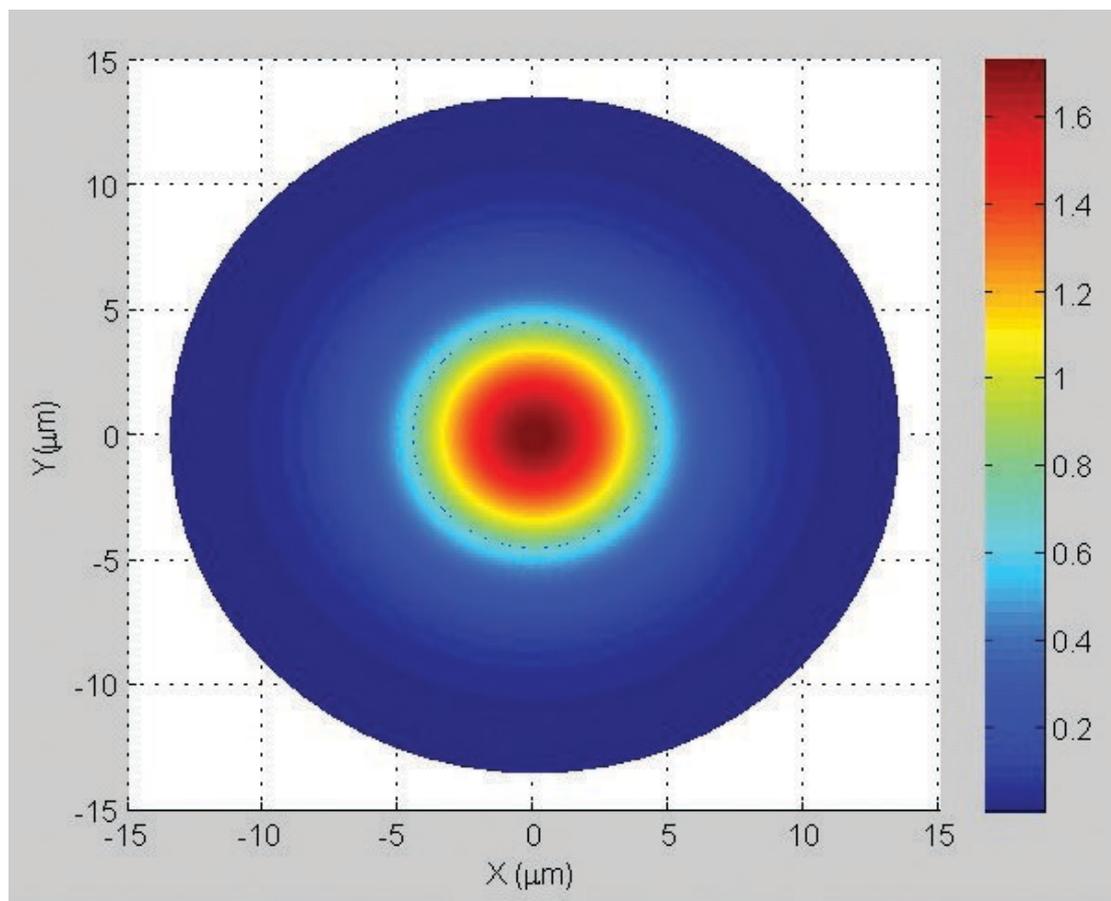
**Figure 1-5** *Numerical aperture*



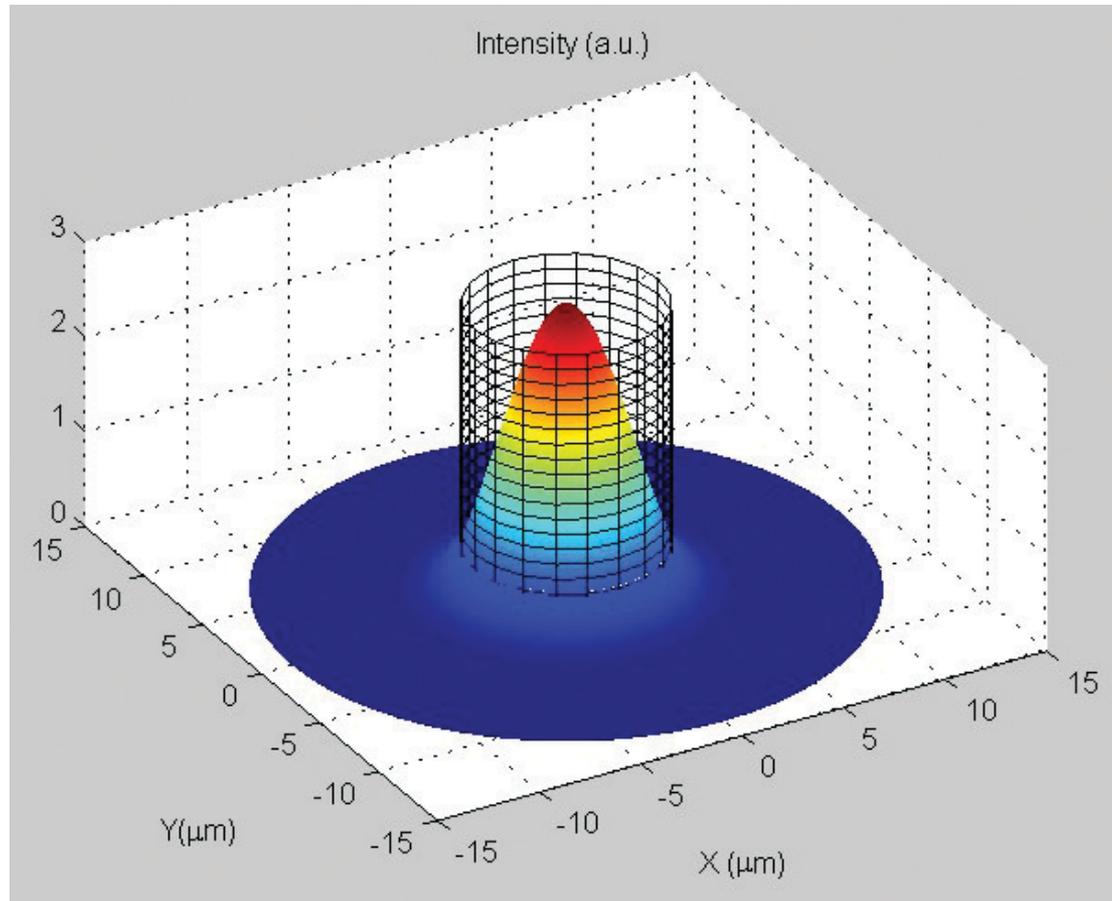
**Figure 1-6** *Illustration of the light direction of propagation for fundamental and higher-order modes of a waveguide*



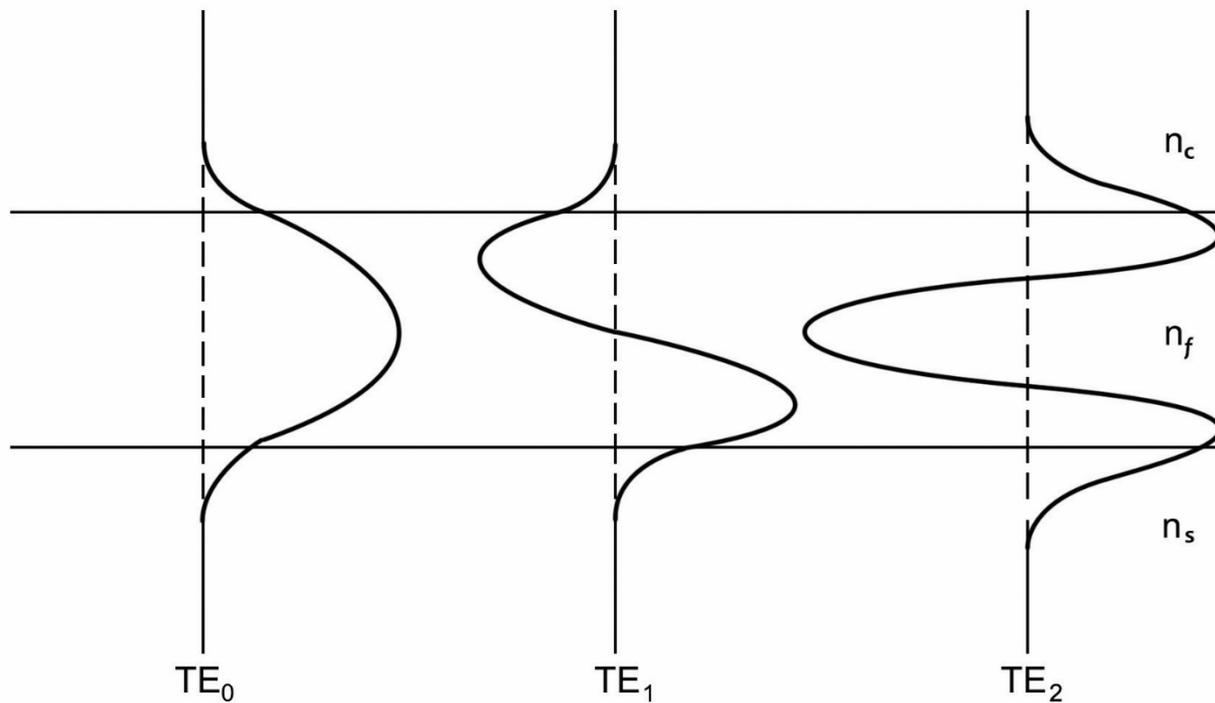
**Figure 1-7** *A transverse electromagnetic wave*



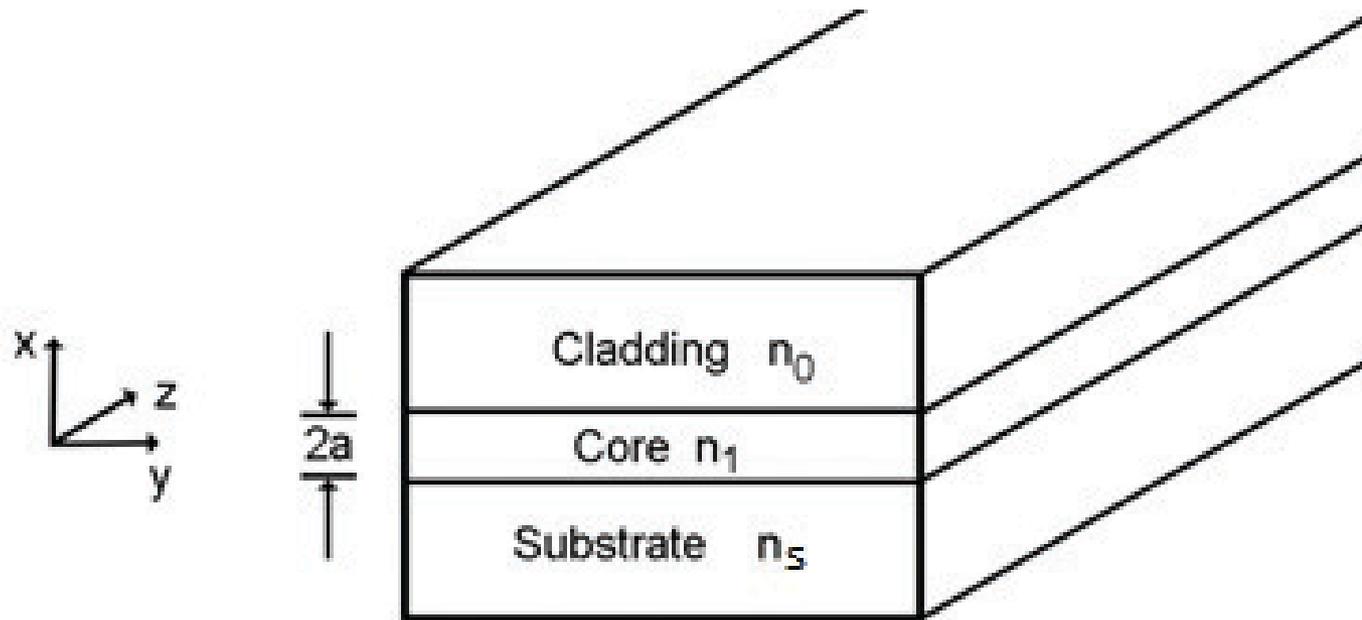
**Figure 1-8 a)** *Intensity of the electromagnetic field in the waveguide cross section of a single-mode optical fiber for the fundamental mode*



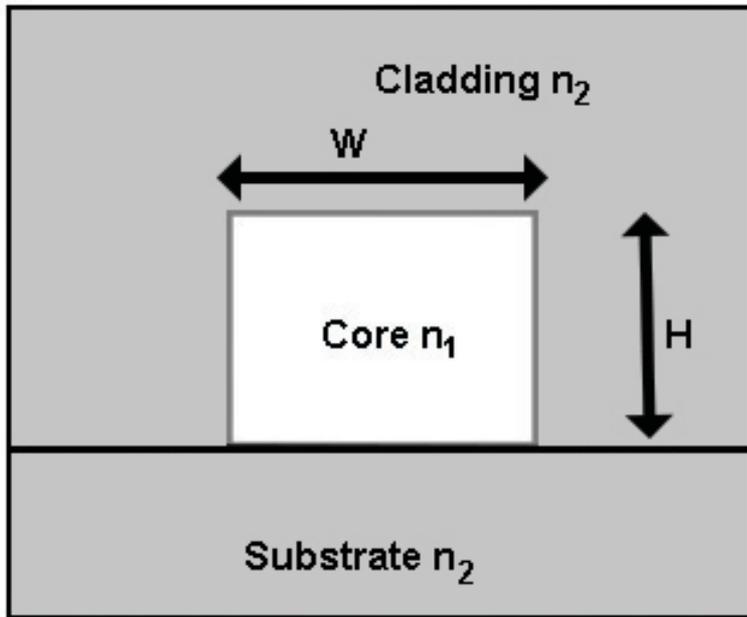
**Figure 1-8 b)** *Three-dimensional representation of the intensity of the fundamental mode*



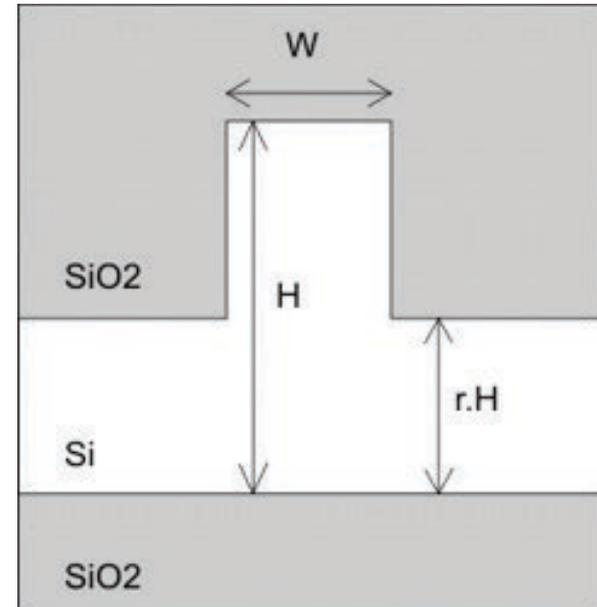
**Figure 1-9** *Intensity distribution for fundamental mode and two higher-order modes along a line passing through the center of the waveguide*



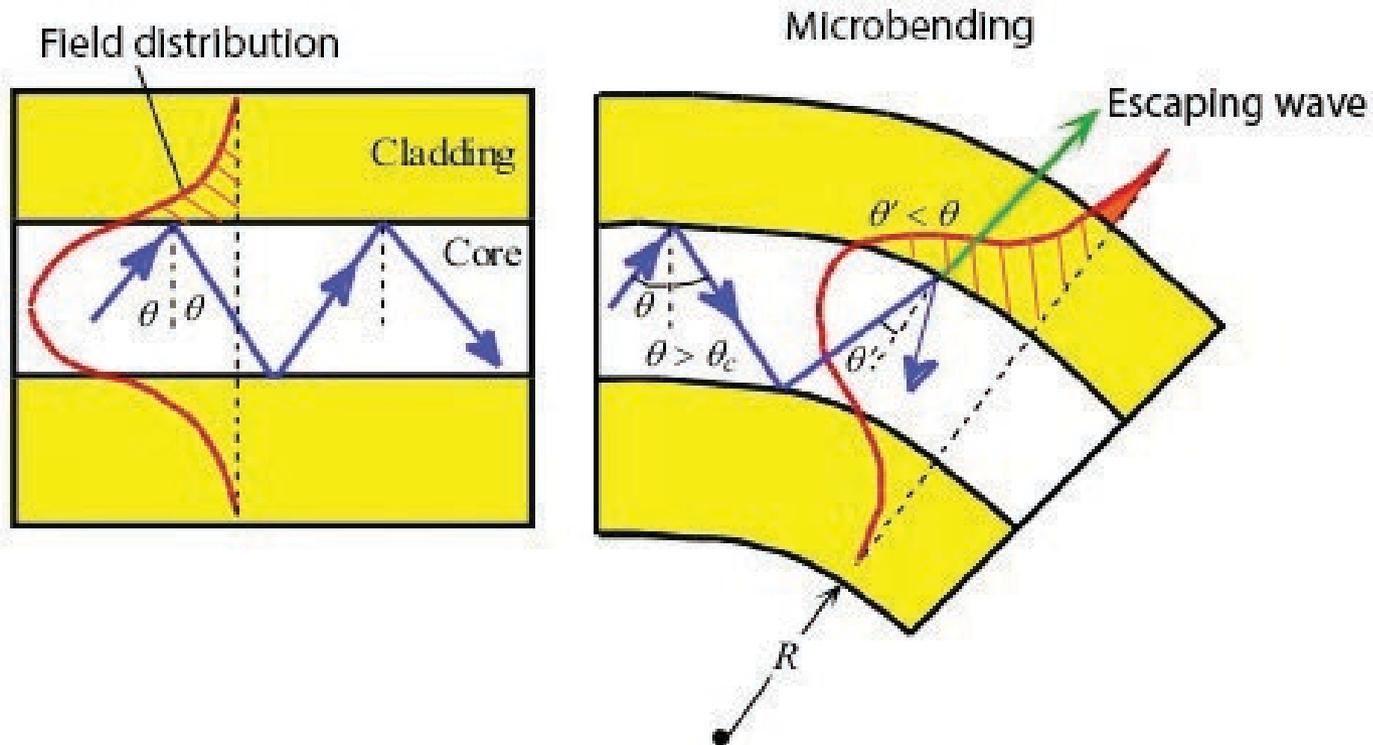
**Figure 1-10** *Planar optical waveguide*



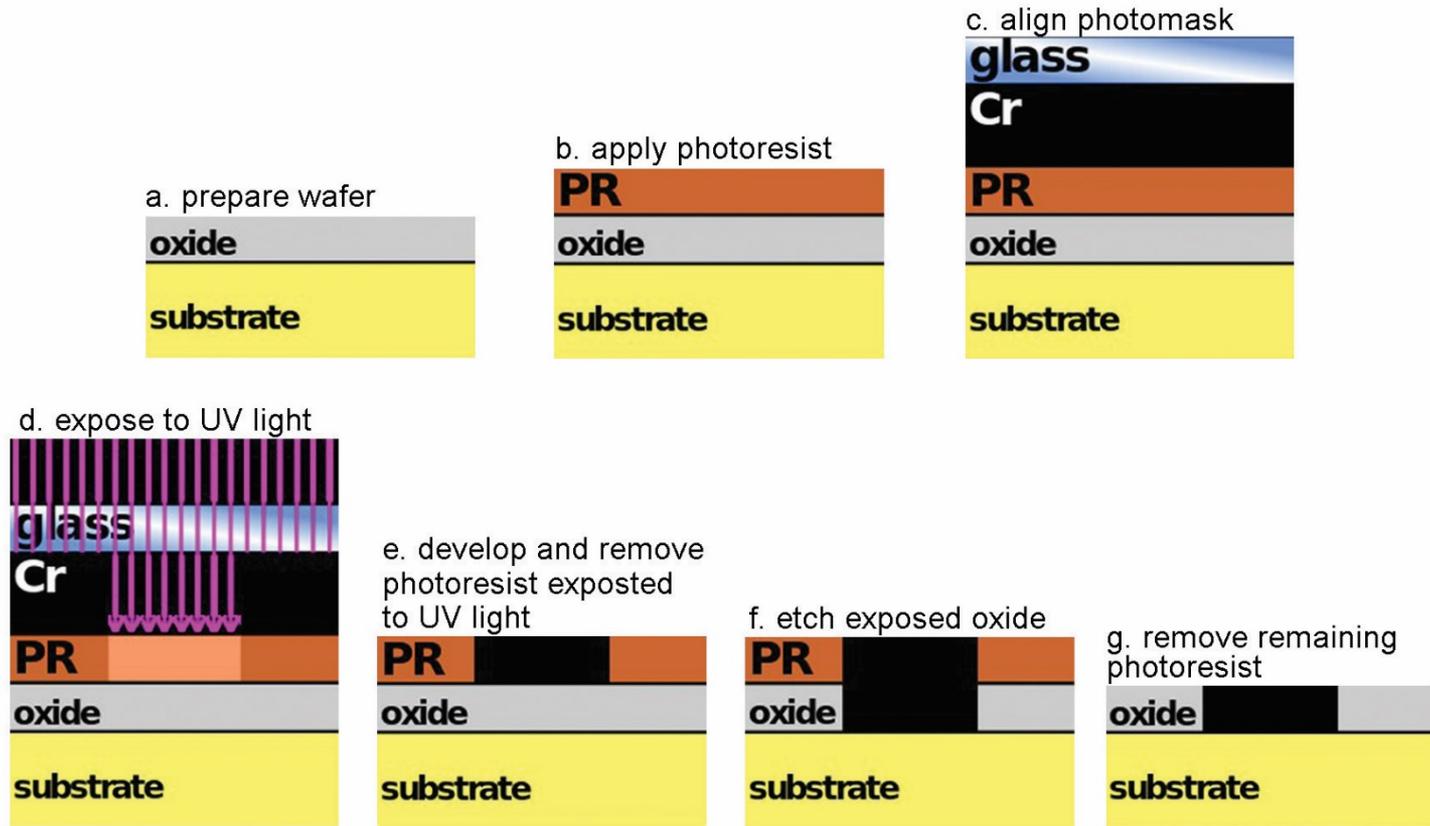
**Figure 1-11 a)** *Channel waveguide*



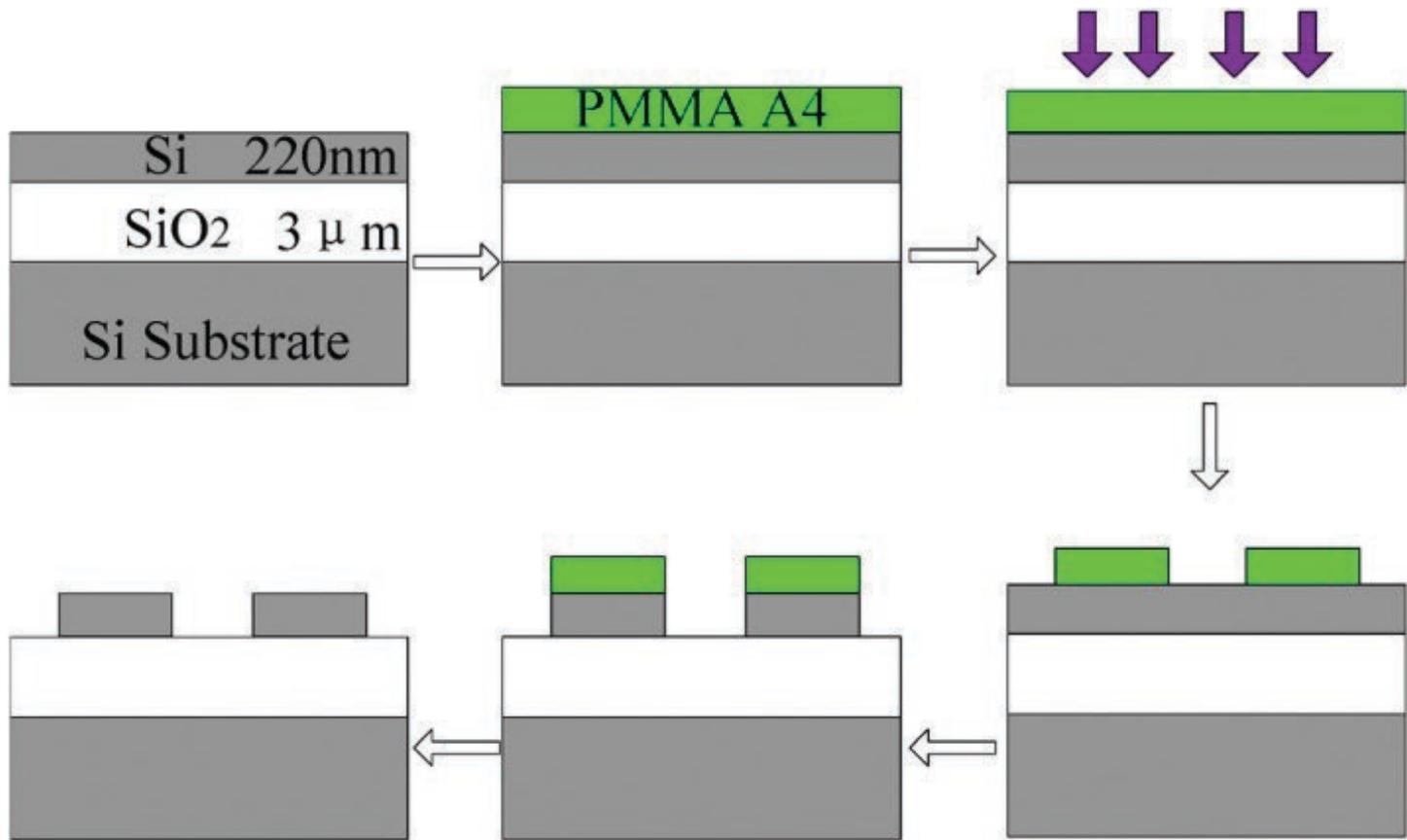
**Figure 1-11 b)** *Ridge waveguide*



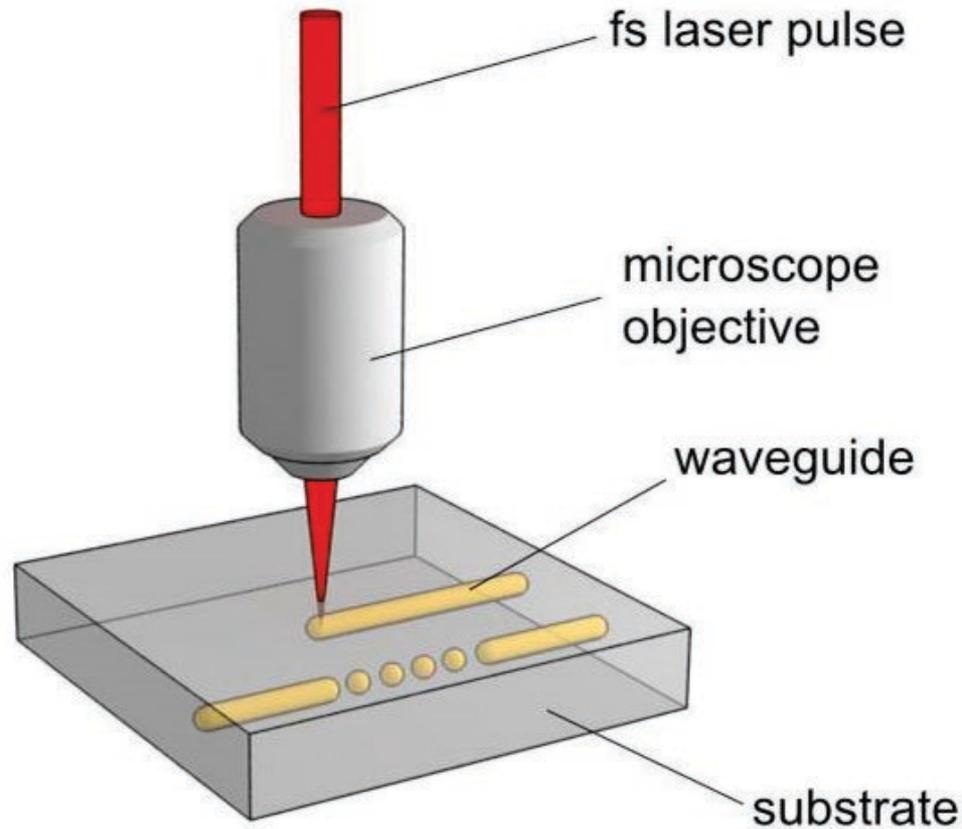
**Figure 1-12** *Light-intensity distribution for straight and bend waveguides. A small amount of light is lost in the bend waveguide due to the violation of the total internal reflection condition.*



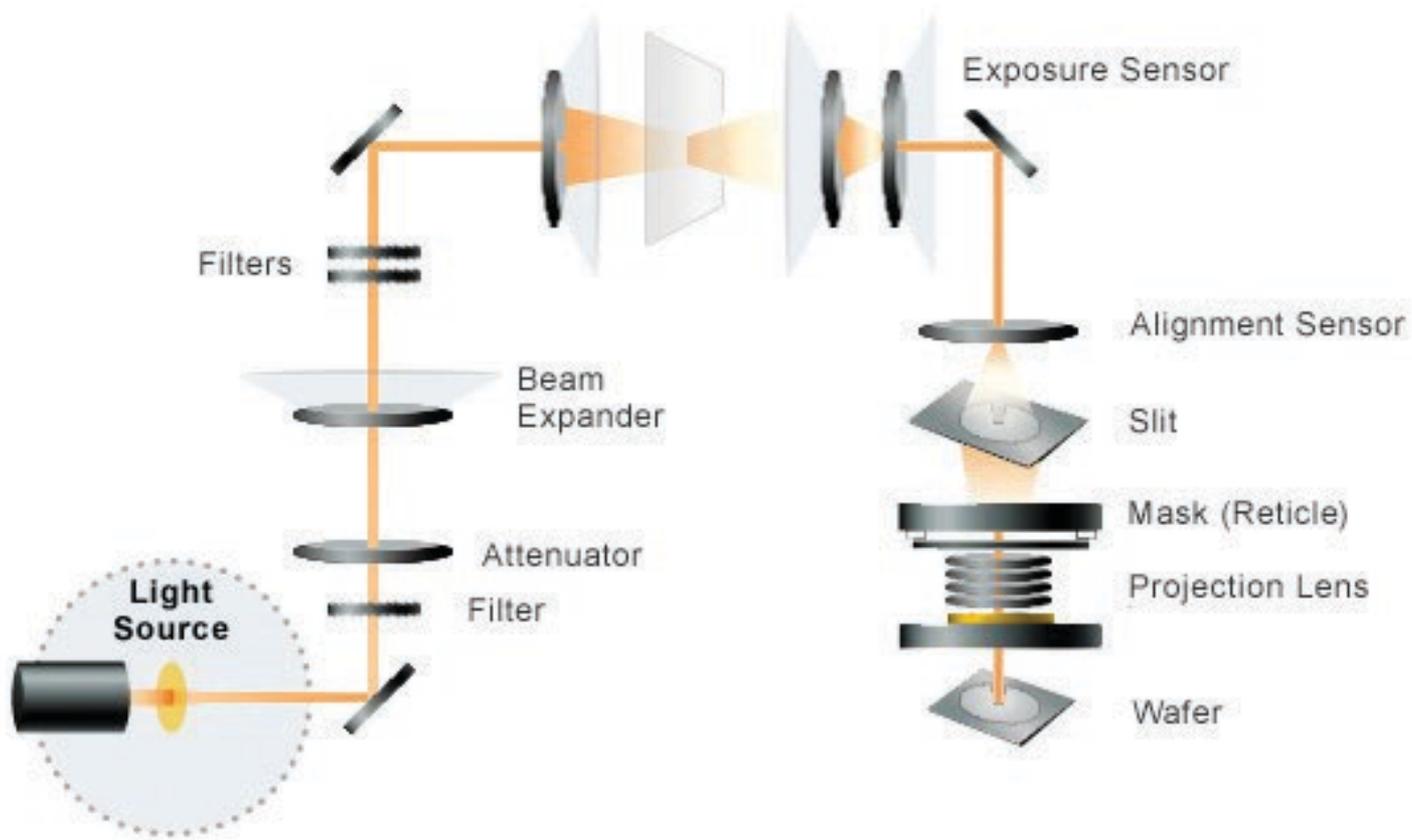
**Figure 1-13** *Photolithography and etching*



**Figure 1-14** *Photolithography and etching of silicon waveguides with silica lower cladding*



**Figure 1-15** *Direct laser writing of waveguides inside a substrate using a femtosecond (fs) laser*



**Figure 1-16** *Reduction scanning photolithography system*



**Figure 1-17** *Commercial RIE equipment used for dry etching*