Lect. 12: Waveguide Devices

Issues for practical waveguides
- Precise control of dimension and refractive index
- Low loss at desired λ
- Mass production possible
- Integration desirable (Integrated Optics)
- Electrical control of refractive index (Electro-Optic effect)

Materials used for waveguides
- Silica ➔ Optical fiber
- Semiconductors: GaAlAs, InGaAsP
- Dielectric materials: $LiNbO_3$ with Ti doping

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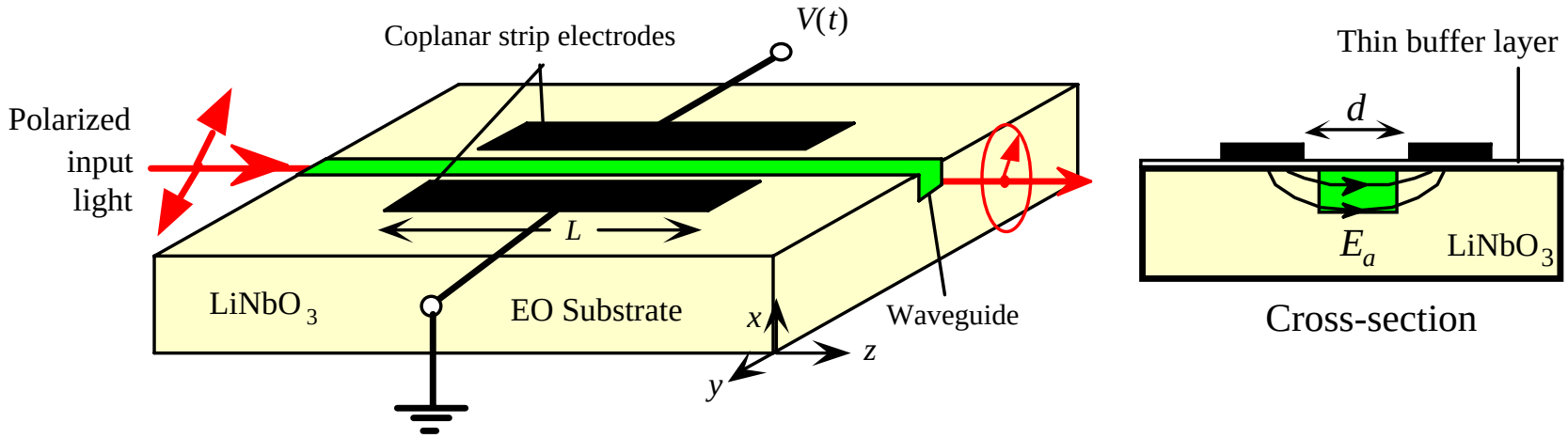
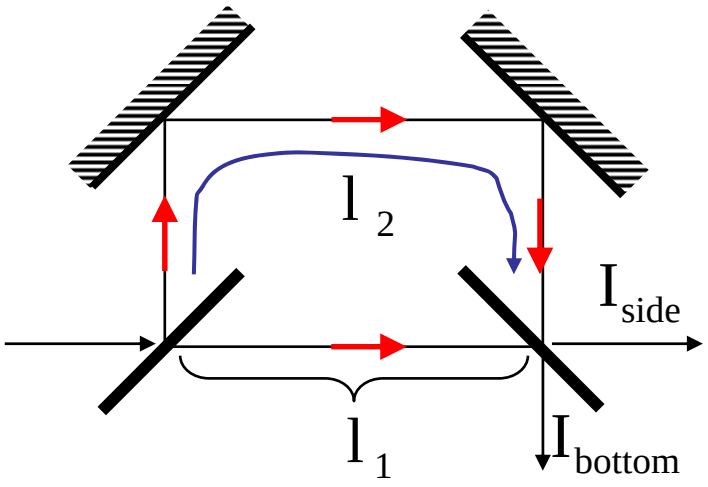
$LiNbO_3$ waveguide



Mach-Zehnder Interferometer:



$$E_{out,side} = \frac{1}{2}\left(e^{-jkl_2} - e^{-j2kl_1}\right) = \frac{1}{2}e^{-jk\frac{l_2+l_1}{2}}\left(e^{-jk\frac{l_2-l_1}{2}} - e^{jk\frac{l_2-l_1}{2}}\right)$$

$$I_{out,side} = \sin^2\left(k\frac{l_1-l_2}{2}\right)$$

$$E_{out,bottom} = \frac{j}{2}\left(e^{-jkl_1} + e^{-jkl_2}\right) = \frac{j}{2}e^{-jk\frac{l_1+l_2}{2}}\left(e^{-jk\frac{l_1-l_2}{2}} + e^{jk\frac{l_1-l_2}{2}}\right)$$

$$I_{out,bottom} = \cos^2\left(k\frac{l_1-l_2}{2}\right)$$

Realize M-Z interferometer with wave devices

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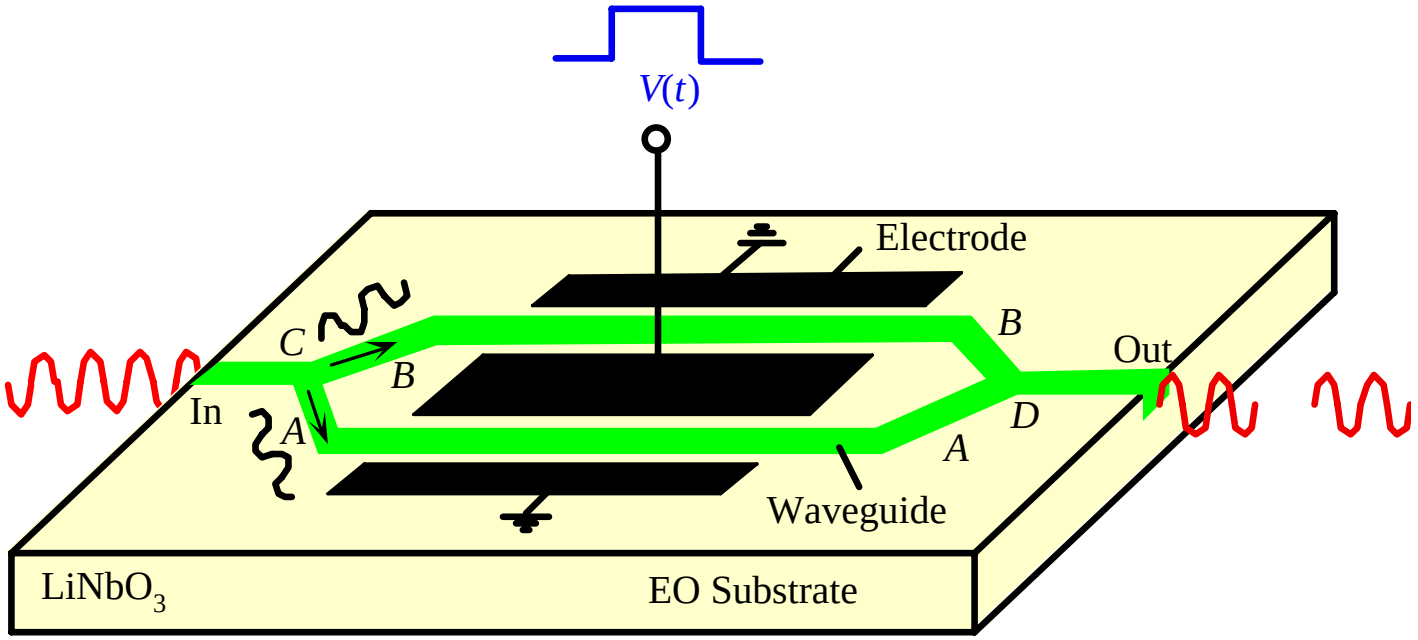
Mach-Zehnder Interferometer (Modulator)



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Exercise Problems:

Part 2: 1,2,3,4