

PHOTONICS TO CONNECT THE WORLD

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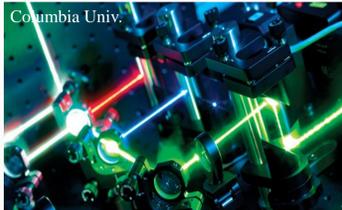
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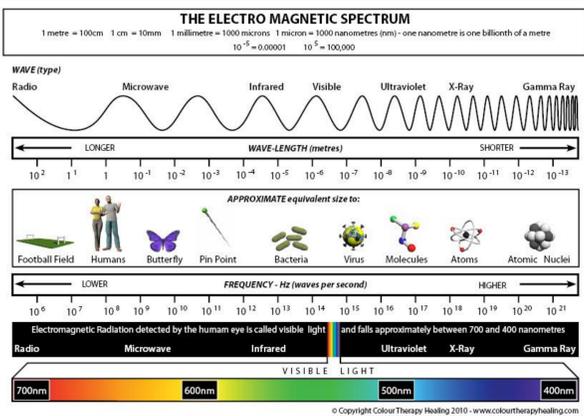
WHAT IS PHOTONICS?

The science of light

- Technology of generating, manipulating and detecting photons



- A photon is an elementary particle, a *quantum*, of electromagnetic radiation

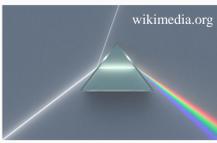


- Visible light is the electromagnetic radiation with wavelengths between 400 and 700 nm



Rainbow: water droplets break sunlight into the seven colours of the visible spectrum

HISTORY IN BRIEF

- In 1670, Sir Isaac Newton observed that white light is composed by different colours 
- In early 20th century, Max Planck and Albert Einstein came to picture light as both a particle and a wave
- The invention of the laser by Dr. Theodore Maiman at Hughes Research Lab in 1960 gave birth to photonics 
Dr. Maiman, HRL Laboratories
- 1964: Townes, Prokhorov and Basov won the Nobel Prize in Physics for the fundamental work on the laser principle
- 1981: Nobel Prize in Physics for laser spectroscopy to Schawlow and Bloembergen

THE 21st CENTURY REVOLUTION

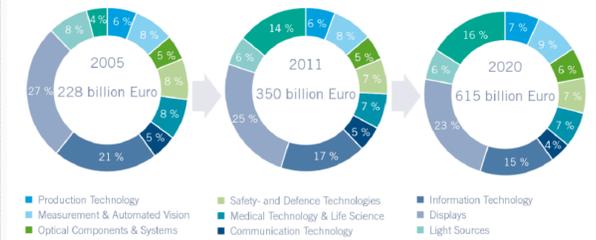
- From a niche activity to a *key enabling technology* to make the 21st century that of the photon
- Nowadays, photonics is **everywhere**
 - consumer electronics
 - health and medicine
 - manufacturing industry
 - defense and security
 - entertainment
 - ...and many more



ECONOMIC IMPACT

- Disruptive economic growth in the world
- The global photonic market will be a € 615 Billion market in 2020

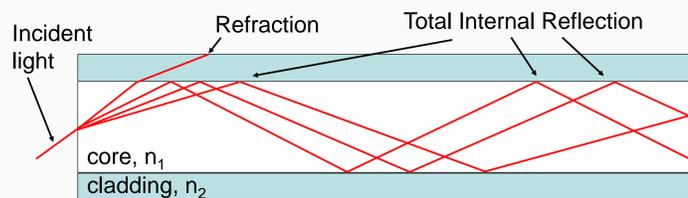
Key Data Photonics World 2005, 2011 and Expectations 2020 photonics21.org



- With a 2015 production volume of € 5.7 Billion (and ~30k employees) **Italy** accounts for 8.3% of the European production

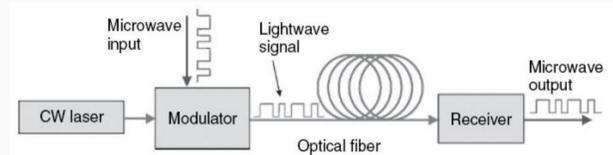
CONNECTING THE WORLD FASTER

- Photonics is the technological **breakthrough** to fulfill the ever-increasing global connectivity demand
- Charles K. Kao, the “Father of Fiber Optics”, discovered that *silica* is an ideal material for long-range optical communication and was awarded the Nobel Prize in Physics in 2009
- Ultrashort light data pulses propagate in thin, flexible and transparent **optical fibres** by total internal reflection, transmitting information



- Optical fibres have large advantages over existing electrical cables (low attenuation and interference → huge bandwidth)
- ...but the optical-electrical-optical conversion for the information processing reduces the transmission data rate

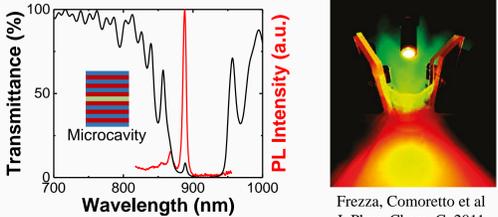
All-optical signal processing



- Our work on optical devices: **ORGANIC PHOTONICS**

Lasers

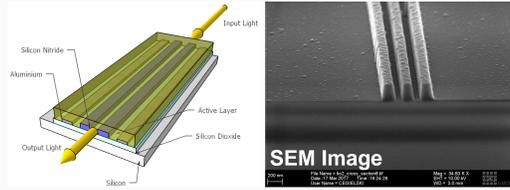
- Lasing: emission of coherent light via optical amplification in a cavity
- Flexible *all-plastic* microcavities embedding fluorescent conjugated polymers for lasing



Transmittance (%), Wavelength (nm), PL Intensity (a.u.), Frezza, Comoretto et al J. Phys. Chem. C, 2011

Modulators

- Modulation: variation of one or more properties of a periodic waveform with a signal containing information
- Electro-absorption modulators: absorbance variation \propto electric field (in progress at UCL and AMO GmbH)



- **Conclusion:** Photonics opens up exciting opportunities for ultrafast interconnections and all-optical computing/processing and is increasing dramatically the connectivity all over the world

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SYNCHRONICS
EU MSCA ETN on *SupramolecularY eNginneered arCHitectures for optoelectRONICS and photONICS*

