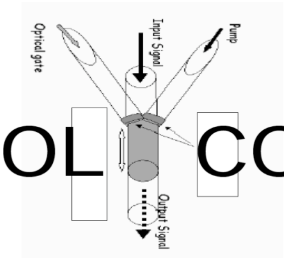
instituto de telecomunicações

Plastic optical fibers (POFs) are a low-cost solution for low-speed, short-distance applications in digital car networks, industrial networks, and home networks and appliances.
The plastic optical fiber is made out of a plastic such as acrylic (PMMA) as the core material and fluorinated or perfluorinated polymers as the cladding materials.
This research addresses the development of low-cost polymer optical fibers and waveguides with integrated gain and optical switching functionalities.

POL 

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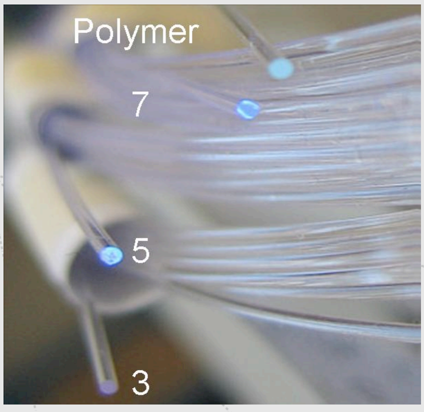
Plastic Optical Fibers (POFs)

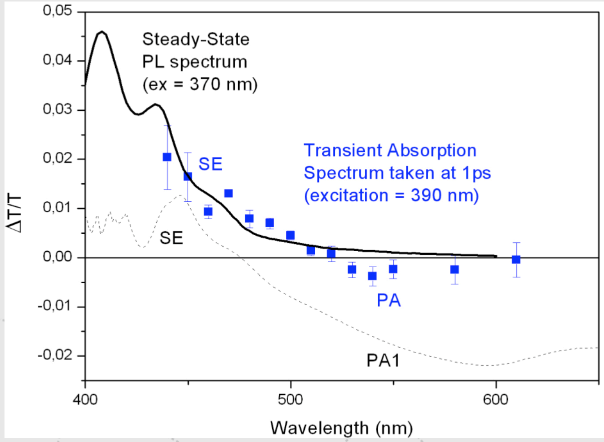
Optical fibers are used to transmit light and, embedded in it, information. The working key principle is the total internal reflection at the interface between the core and the cladding (having a lower refractive index), which confines the propagating light beam within the core.

Losses, due to scattering and absorption, limit the distance at which light can be transmitted.
Silica is the material of choice for long distance transmission, being nearly transparent in the infra-red. So the selected wavelengths for data transmission are 850, 1310 and 1550 nm. Furthermore, the use of erbium as a dopant allows signal amplification when transmitting at 1.5 µm wavelength, which has led to a drastic improvement of this technology. However silica optical fibers are expensive, brittle and, having cores with diameters around 50µm, make the connections difficult to perform.
Plastic/polymeric optical fibers (POFs) are competing with silica fibers for short distance transmission (Local Area Networks, automotive, sensors) as they are flexible and, having larger cores, easier to connect. Polymethylmethacrylate, PMMA, is one of the most used core materials. However, losses are higher than in silica, limitting the application to shorter distances. Recent studies show that the use of fluorinated polymers as core materials significantly reduces losses.

The aim of the project is to explore conjugated luminescent polymers, which show stimulated emission, as amplifiers of POFs, thereby played a role similar to that of erbium in the silica fibers. Furthermore, the gain of these conjugated polymers can be switched off, with a laser beam, in time scales around 1ps. This effect is being explored in ultrafast optical switches.



This photo shows four doped organic optical fibers, The active materials are fluorene oligomers of different lenghts: a trimer (3), a pentamer (5), a heptamer (7), and a long chain (polymer)



SE band enlarged compared with pure PFO film.

Following the first observation (Phys. Rev. Lett. 94 (2005) 117402) that dilution of a conjugated luminescent polymer (a polyfluorene) in PMMA was enlarging the spectral region where stimulated emission (SE) was observed, this combination is being explored for POFs showing gain and ultrafast switching.

In order to optimise these blends for POF applications, we are exploring different conjugated polymers and oligomers (top, left hand side) to both tune the gain spectral region and maximise that gain. Furthermore, the load of the conjugated polymer in the PMMA matrix should be maximised, to increase gain, while avoiding the chains of the conjugated polymer to aggregate (fully disperse system).
The approach being followed to achieve that goal consists on the covalent binding between the conjugated polymer chains and the PMMA chains (copolymer approach). The results shown at the top at the right hand side were obtained for one of such copolymers. The blue squares correspond the stimulated emission of this copolymer which occurs in a broader spectral range than for the pure conjugated polymer (dotted line). Other conjugated polymers and copolymerization strategies are being developed to improve doped-POF performance in terms of attenuation, gain and, eventually, switching.

Further information can be seen at http://www.fisi.polimi.it/polycom/

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