

MIQUEL RUDE
Adjunct Prof. Dr. Maria Muñoz



PhD Thesis Defense MIQUEL RUDE 'Micro-Nano Structured Optical Devices using Ge₂Sb₂Te₅'

MIQUEL RUDE

December 01, 2016

Thursday, December 1, 15:00. ICFO Auditorium

MIQUEL RUDE

Optoelectronics

ICFO-The Institute of Photonic Sciences

Photonic devices are key to implement future communication and information technologies. Their success is largely determined by our capability to appropriately control light in such devices, especially in future reconfigurable networks. Light does not interact with itself, thus one usually needs the use of an active material. Phase change materials are a potential candidate to implement this functionality. These materials are a group of chemical compounds that exist in more than one stable phase, each with largely different electrical and optical properties. Moreover, they can be rapidly and reversibly switched between these phases using electrical or optical pulses. This thesis is devoted to the design and

implementation of micronano structured photonic devices incorporating the phase-change material Ge₂Sb₂Te₅ (GST). The thesis first investigates how to fabricate thin films of different phase-change materials in a repeatable manner and characterizes their main properties, especially those of GST. This includes an investigation of their composition, the conditions required to reversibly switch between the amorphous and crystalline phases, as well as their optical properties in each of the stable phases. Three different applications are then demonstrated, each of them based on a different functionality.

The first application is an optical switch operating at telecommunication wavelengths. The device is implemented using a racetrack resonator partially covered with GST. The transmission resonances present in this system are controlled using an infrared laser that triggers phase transitions in the GST layer, thus modifying the shape and position of the resonance wavelength between two states. The switch has an on/off ratio of ~ 12dB and response times of ~ 5 ns.

In the second application, control of surface plasmon polaritons in Au waveguides is demonstrated. This is achieved using a cladding layer of GST. 100 % modulation is achieved for large GST areas and thermal crystallization, while up to 30 % modulation is achieved using small GST areas and laser crystallization.

The third application is related to nanohole arrays covered with GST thin films. The effect of phase transitions in the transmission resonances of these structures is investigated for three geometries. Wavelengths shifts as large as 385 nm are demonstrated in devices with broad resonances. Additionally, excitation of GST with short pulses allows for ultrafast tuning of these resonances in the ps regime without the need for a phase transition. Finally, tuning of narrow resonances with shifts of 13 nm is also shown. In summary, the studies and applications contained in this thesis demonstrate the potential of GST and, in general, phase-change materials, to address optical tunability, which is an essential function in a wide range of optical devices.

Thursday, December 1, 15:00. ICFO Auditorium

Thesis Director: Prof . Dr. Valerio Pruneri

