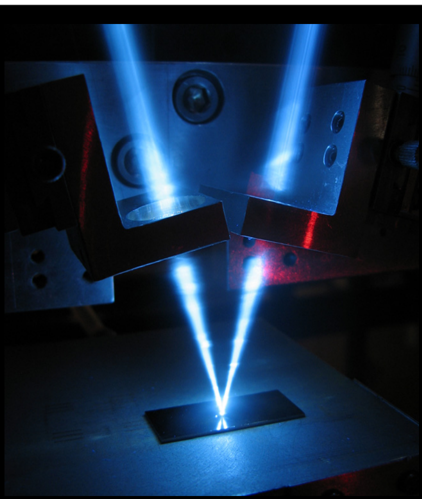
Imaging of Single-step UV-laser-written Channel Waveguides by Confocal Micro-luminescence

Daniel Jaque
Departamento de Fisica de Materiales, Universidad Autónoma de Madrid, Madrid, Spain
F.R. Mahand Adikan, J.C. Gates, C.B.E. Gawith and P.G.R. Smith
Optoelectronics Research Centre, University of Southampton, Southampton, United Kingdom

We report on the observation of confocal micro-luminescence originated by defects created in direct UV written silica-on-silicon waveguides. Spatial and spectral analysis of the visible luminescence bands was performed with 488nm excitation. This has revealed the UV formation of different defects which are related to the different compositions of core and cladding layers.



Producing the Waveguides: Direct UV-writing

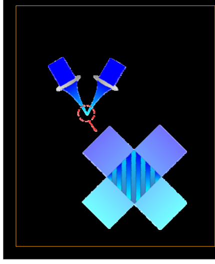
Is a method of defining waveguide structures by exposing a photosensitive silica sample to UV light. By translating the sample underneath the focused UV beam, waveguide structures such as straight channels and y-splitters can be formed.

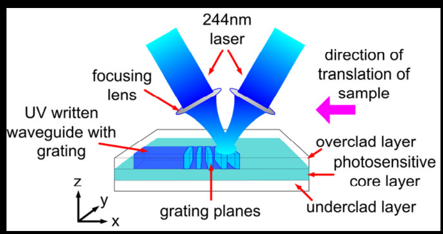
Direct Grating Writing (DGW) (delete: involves) utilizes the interference pattern generated by crossed UV beams and allows simultaneous definition of channel waveguides and grating structures.

The UV interference pattern is generated by crossing two tightly focused coherent UV beams at a fixed point in space.

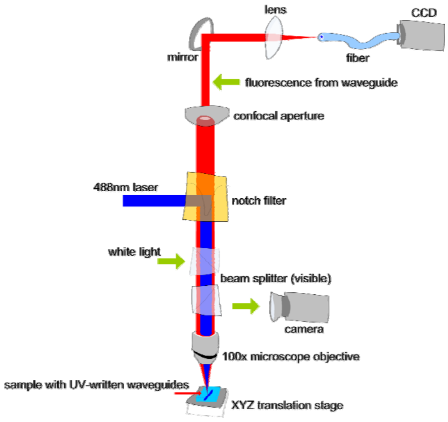
A photosensitive sample is then aligned with this interference spot and translated relative to it.

If the writing laser is not modulated during the writing process (i.e. continuously on), the effect of the interference pattern is averaged out, producing channel waveguides similar to those produced using DUW. An interference pattern is produced on the sample if the writing spot laser is modulated with a frequency between subsequent exposures being the period of the interference pattern required.

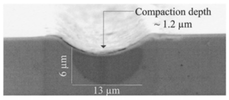




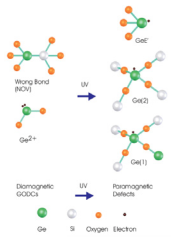
Confocal micro-luminescence



The origin of UV photo-sensitivity



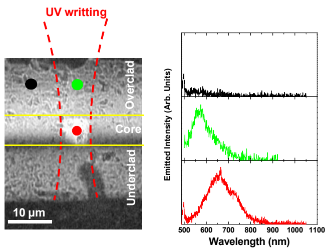
Local densification



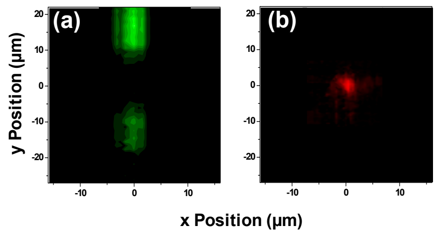
Defect creation

Results:

Different layers; Different UV induced defects

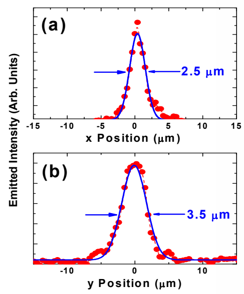


Left.- Optical transmission micro-picture of a UV written waveguide. The different wafers constituting the substrate are indicated. The UV fluence used in this case was 22 kJcm^{-2}. The presence of the channel waveguide is clearly denoted by the bright spot. **Rigth.-** Micro-PL spectra obtained after 488 nm excitation at different positions indicated by black, green and blue points in the micro-picture at the left.



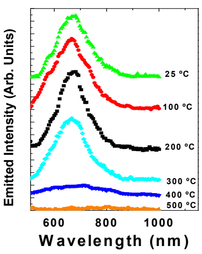
Spatial dependence of the emitted intensity at 570 and 670 nm obtained after 488 nm excitation ((a) and (b), respectively). Data correspond to a channel waveguide written with a laser fluence of 22 kJcm^{-2}.

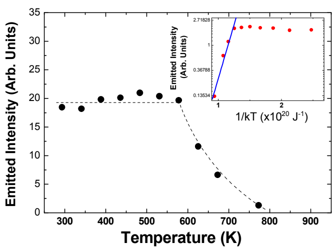
Waveguide dimensions



Emitted intensity at 670 nm (red dots) obtained after 488 nm excitation obtained along the (x = 0, y) and (y = 0, x) directions (Figures (a) and (b), respectively). Data corresponding to a channel waveguide written with a laser fluence of 22 kJcm^{-2}. Solid lines in blue are the best fits to a Gaussian function.

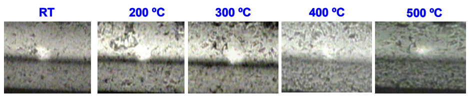
Thermal resistance of UV induced defects

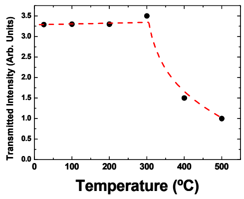




Left.- Micro photoluminescence spectra obtained from the waveguide after different thermal annealing procedures. Right.- Integrated emitted intensity as a function of the annealing temperature. Dots are experimental data and the dashed curve is for indicative purpose only. Data correspond to the waveguide written with a UV laser fluence of 22 kJcm-2.

Thermal resistance of UV written waveguides





Top.- Optical transmission micro-pictures of a UV-written channel waveguide after different annealing treatments. Bottom.- Waveguide transmitted intensity as a function of the annealing temperature. Dots are experimental data obtained from the optical transmission micro-pictures and the dashed curve is for indicative purpose only. Data correspond to the waveguide written with a UV laser fluence of 22 kJcm^{-2}

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