Characterization of polycrystalline zinc sulfide waveguides for nonlinear photonic

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The nonlinear optical phenomenon resulting from matter-radiation interaction has been considerably improved thank to the development of photonic devices allowing strong confinement of the electromagnetic field within a guiding structure based on a nonlinear optical material. [1]. Up to now, only few studies have been focused on zinc sulfide (ZnS). This material is promising for non-linear optics since it has as a high refractive index at telecom wavelengths [2], a wide spectral band of transparency, high second [3] and third order non-linear coefficients [4] and a polycrystalline structure that can potentially be put to good use for non-linear process [5]. The variety of ZnS deposition methods, some of them low-cost, also represents an interesting technological advantage from an application point of view.

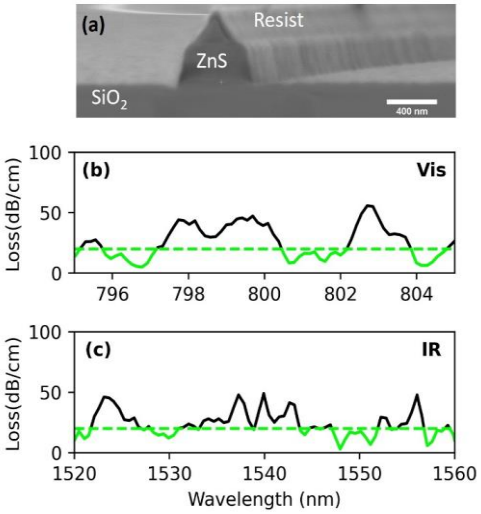

Fig.1 a. SEM image of a clived ZnS waveguide. b,c Propagation losses in visible and infrared region. Values in green are less than 20 dB/cm

In this work and for the purposes of integrated nonlinear optics, we investigate the structural properties of ZnS thin films deposited by magnetron sputtering thru different technics, including atomic force microscopy (AFM), scanning electron beam microscopy (SEM) and DRX measurements. Optical properties of this films are also studied by ellipsometry. The fabrication process for the first waveguides (fig 1.a) from this new photonics platform is then described, along with their optical characterizations by Fabry-Perot contrast measurement [6] (fig 1. b,c). Finally, we study theoretically the non-linear processes that can be envisaged in such photonic structures, in view of the presented structural characterizations.

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References

[1] Wang et al, Optica 5, 1438-1441 (2018)
[2] M. Debenham, Appl. Opt., vol. 23, no 14, p. 2238, juill. 1984
[3] H. P. Wagner et al, Phys. Rev. B, vol. 58, no 16, p. 10494-10501, oct. 1998
[4] T.-Y. Zhou et al, Nanotechnology, vol. 16, no 4, p. 536-541, avr. 2005
[5] Baudrier-Raybaut et al. Nature 432, 374–376 (2004).
[6] Regener, R., Sohler, Appl. Phys. B **36**, 143–147 (1985)