RENOS: Rare Earth Doped Novel On-Chip Sources

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Objective

Main goal of the RENOS project is to develop a compact, low cost, power efficient tunable laser and frequency combs spanning large bandwiths, exhibiting excellent output beam characteristics.

Those sources will be beneficial for applications in optical sensing, spectroscopy, metrology and telecommunications.

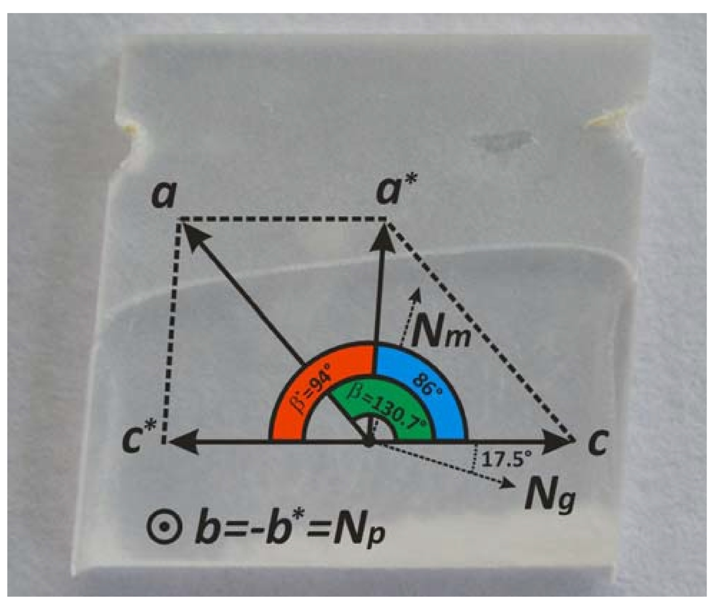
Material

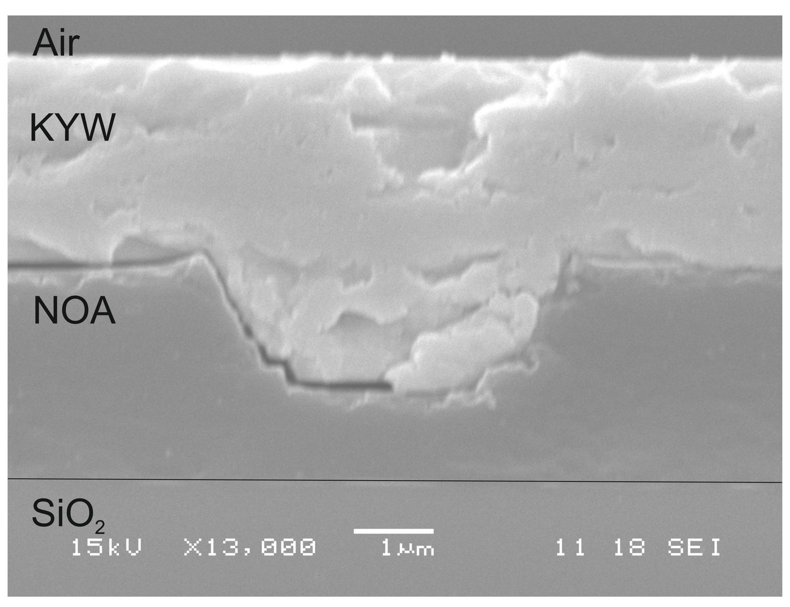
Monoclinic rare-earth-doped potassium double tungstate (Re:KY$(WO_4)_2$ or shortly KYW) will be used as host material because:

- High refractive index
- Relatively high non-linear coefficient
- Allows high dopant concentrations
- High absorption and emission cross sections for rare earth ions doped in this host material

Due to those characteristics it will be possible to obtain:

- High-Q ring resonators
- Low threshold four-wave mixing
- Low threshold stimulated Raman scattering

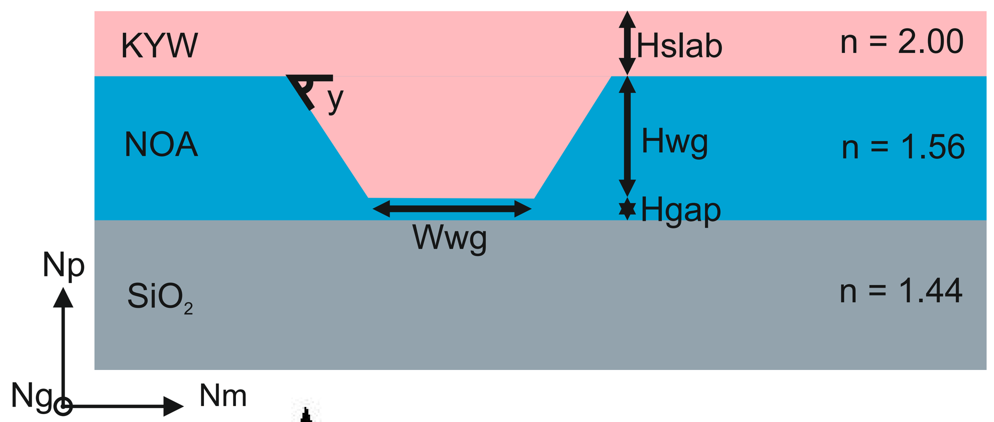




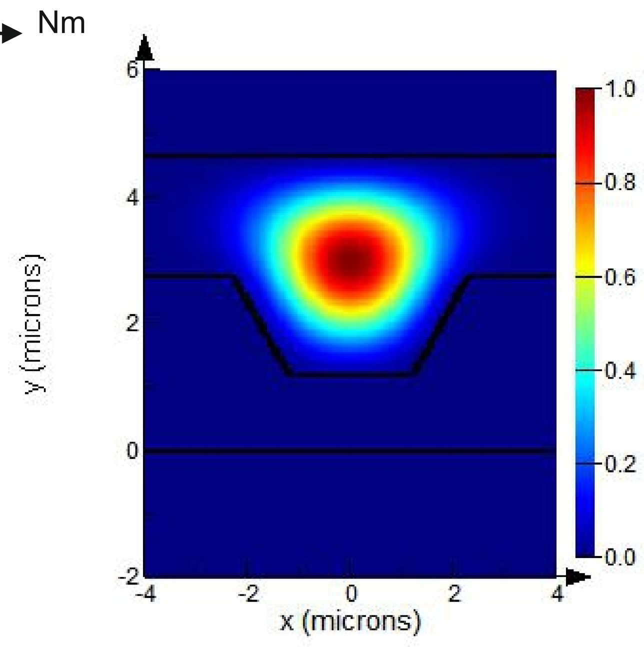
left) Orientation of the crystallographic axes of undoped KYW. Two different choices of lattice vectors are indicated, neither of which line up with the axes of the indicatrix [1]. right) SEM image of a 20% Er:KYW waveguide (single mode) that is produced in the Optical Sciences goup. The KYW rib waveguide is flip-chip bonded with NOA81 (Norland Optical Adhesive) on a silicon oxide substrate.

Simulation

Simulations of the cross-section of the waveguide are made with the software Lumerical MODE solutions to find the parameters such that the structure is single mode. The parameters of the structure are shown in the figure below and listed in the table.



Structure	Size (μm)
Wwg	1.60 - 2.40
Hwg	1.55
Hgap	1.20
y	55°
Hslab	≥1.9



left) Simulation results (2D simulation) for the mentioned structure (Wwg = 2.4 μm). The simulations are done at a wavelength of 1.55 μm.

Simulation window 40 x 12 μm^2 with a mesh of 80 x 80 nm^2 and a mesh override in the waveguide region with a grid of 40 x 40 nm^2.

Real mode has:

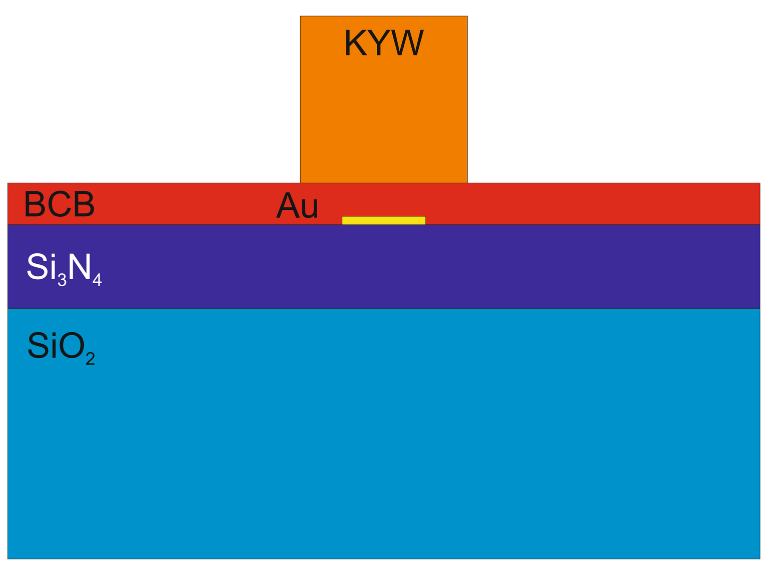
- Effective refractive index of mode ≥ effective refractive index of background
- Field is confined in simulation region.

Future work

Earlier numerical studies for a structure as shown below have shown that:

- The anisotropy of KYW has no detrimental effect on the bend losses [2]
- A metal layer can compensate for the losses in long-range dielectric-loaded surface plasmon-polariton waveguides [3]
- A metal layer can reduce the bend losses for TE modes for bends with a radius ≤ 2.5 μm [4]

We will investigate if those numerical results can be reproduced in reality.



The height and width of the KYW ridge are 800x800 nm^2, the adhesive BCB layer has a thickness of 100 nm and the Si_3N_4 buffer layer has a tickness of 350 nm.

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References:

[1] D. Geskus, PhD-thesis, University of Twente 2011)
[2] T. Dubbink et al., IEEE ICTON, pp. 1-4, (2013)
[3] S.M. García-Blanco et al., Opt. Express, 19 (25), p25298-25310 (2011)
[4] T. Dubbink, Bachelor thesis, University of Twente, (2012)