Maximizing intensity in TiO_2 waveguides for nonlinear optics

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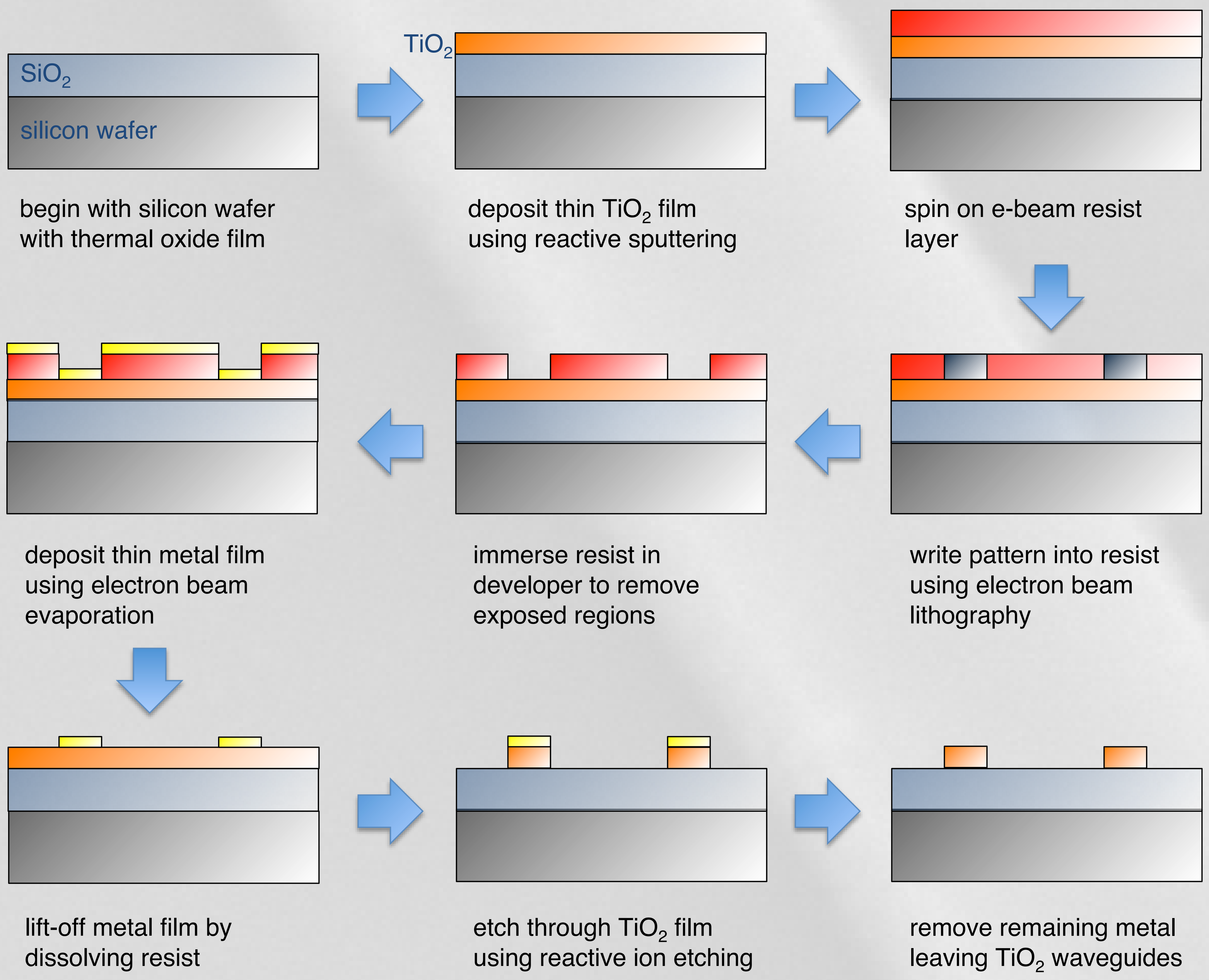
Overview

TiO_2 is a widely transparent, highly nonlinear novel photonic material that has potential applications in all-optical switching and other nonlinear processes. In order to best exploit it's large nonlinearity, we have optimized our fabrication process and have simulated design parameters that aid in producing and maintaining large pulse intensities within integrated photonic structures.

Fabrication steps

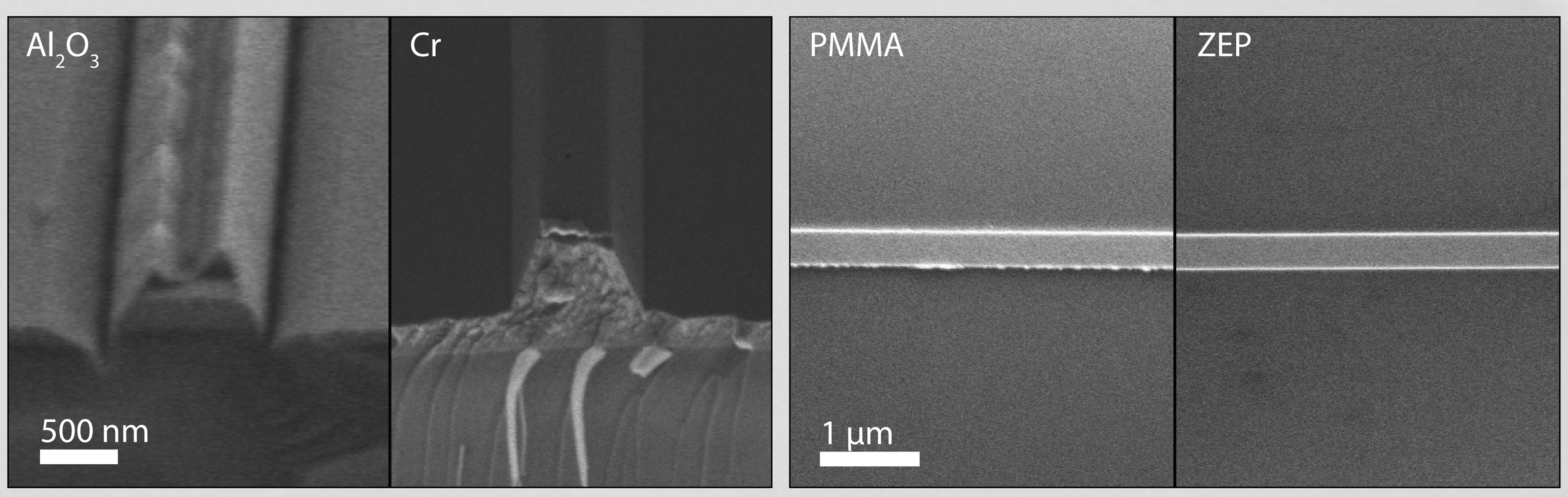


Fabrication materials

Smooth features are important to achieve low propagation losses in photonic waveguides. We achieve the most consistent etch by using chromium as an etch mask compared to aluminum oxide (left). We also obtain smoother features by using ZEP as a resist instead of PMMA (right).

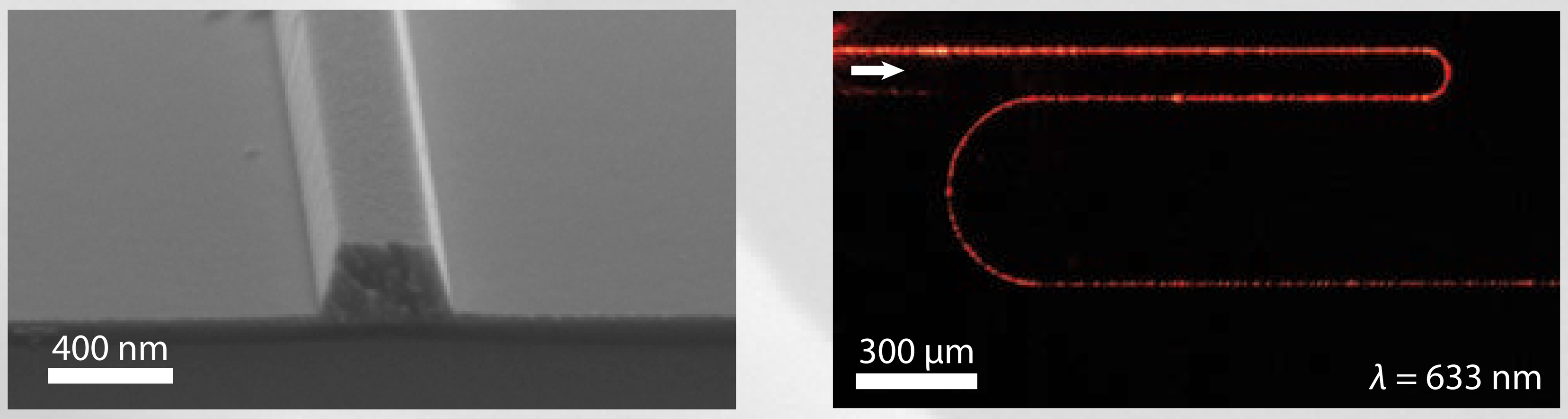
etch mask comparison

e-beam resist comparison



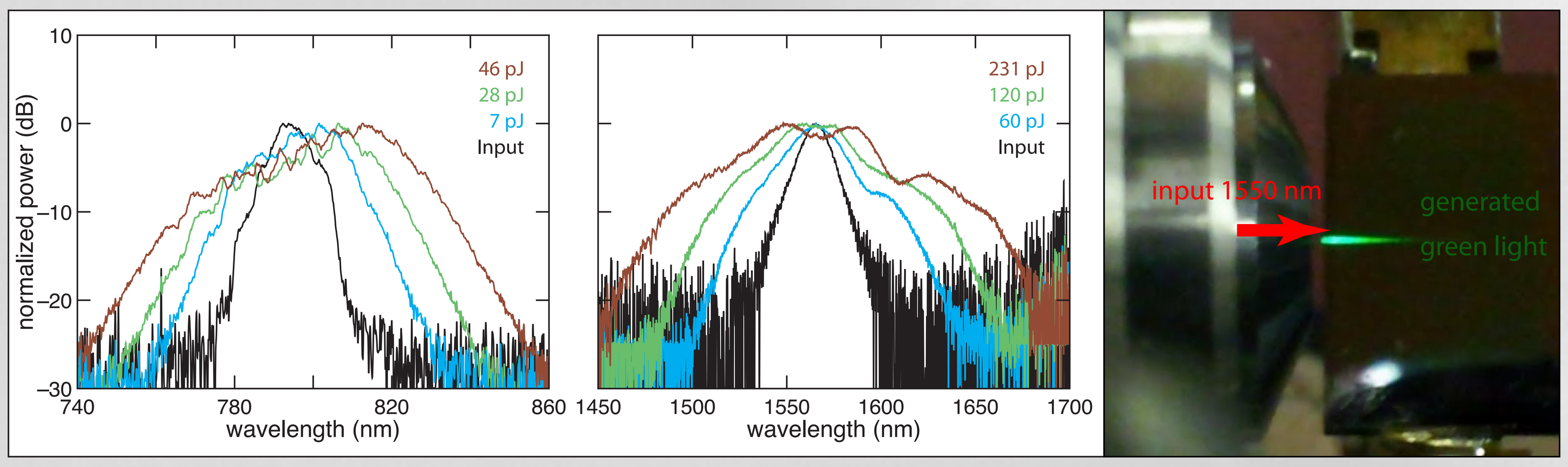
Waveguides

Once fabricated, TiO_2 photonic waveguides have trapezoidal cross sections (left) and are capable of guiding visible light (right).



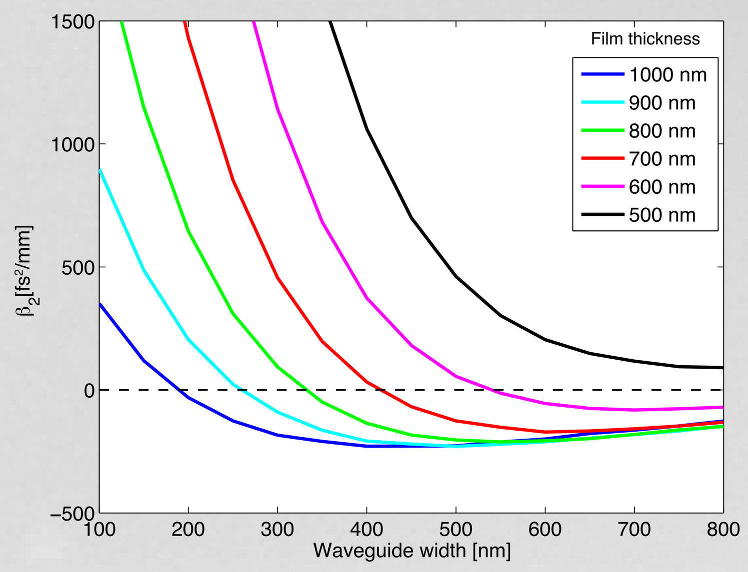
Nonlinear properties

A short pulse in a nonlinear waveguide generates new wavelengths. Here, we show spectral broadening at both 800 nm (left), 1550 nm (middle), and green-light from 1550 nm pulses (right).



Dispersion engineering

Nonlinear effects cause ultrafast pulses to broaden, disperse and thus attenuate. By tuning the waveguide geometry, we obtain anomalous group velocity dispersion which directly counters these effects and produces optical solitons.



Coupling pads

We can optimize for insertion losses by fabricating low index polymer coupling pads (top). Using an adiabatic taper, we can increase our waveguide input coupling efficiency by 30% by implementing a coupling pad (bottom).