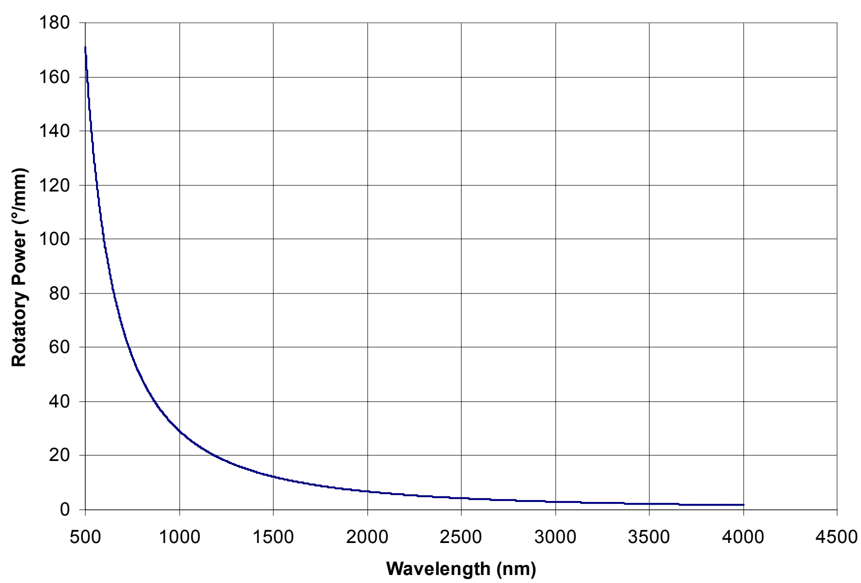
TeO_2 Optical Rotator

Quartz optical rotators based on optical activity have been used extensively in a wide variety of optical systems because they are insensitive to rotation and only require alignment normal to the incident beam. However, due to small rotatory power at 1550 nm (~1.4°/mm), it is impractical to use quartz rotators in polarization-based passive fiber-optic telecommunications components and other near-IR optical systems. We have recently discovered TeO_2 can be grown in both dextro-rotatory and laevo-rotatory orientations. This allows both clockwise and counter-clockwise polarization rotation to be achieved with crystals of reasonable length. Our new TeO_2 optical rotators exhibit the following characteristics:

- Wide transparency: 0.33-5.0 μm
- High rotatory power in the near-IR (~11.5°/mm@1550 nm)
- Easy alignment: rotator is aligned normal to the incident beam (no rotational alignment required)
- Very low temperature sensitivity
- Low cost
- On either side of the design wavelength, the polarization remains purely linear (unlike half-waveplates where the polarization becomes elliptical)
- For birefringent filters used in telecommunications, all filtering crystals can be fabricated with the same orientation, and multiple TeO_2 rotators can used to set the polarization rotation for each crystal. Thus, mechanical rotation or multiple crystal orientations are eliminated.
- Low loss: visible/near-IR anti-reflection coatings with R<0.15% per surface can be easily applied. The material itself has negligible absorption from 400-4000 nm.

The rotatory power of TeO_2 as a function of wavelength is shown below[1]:



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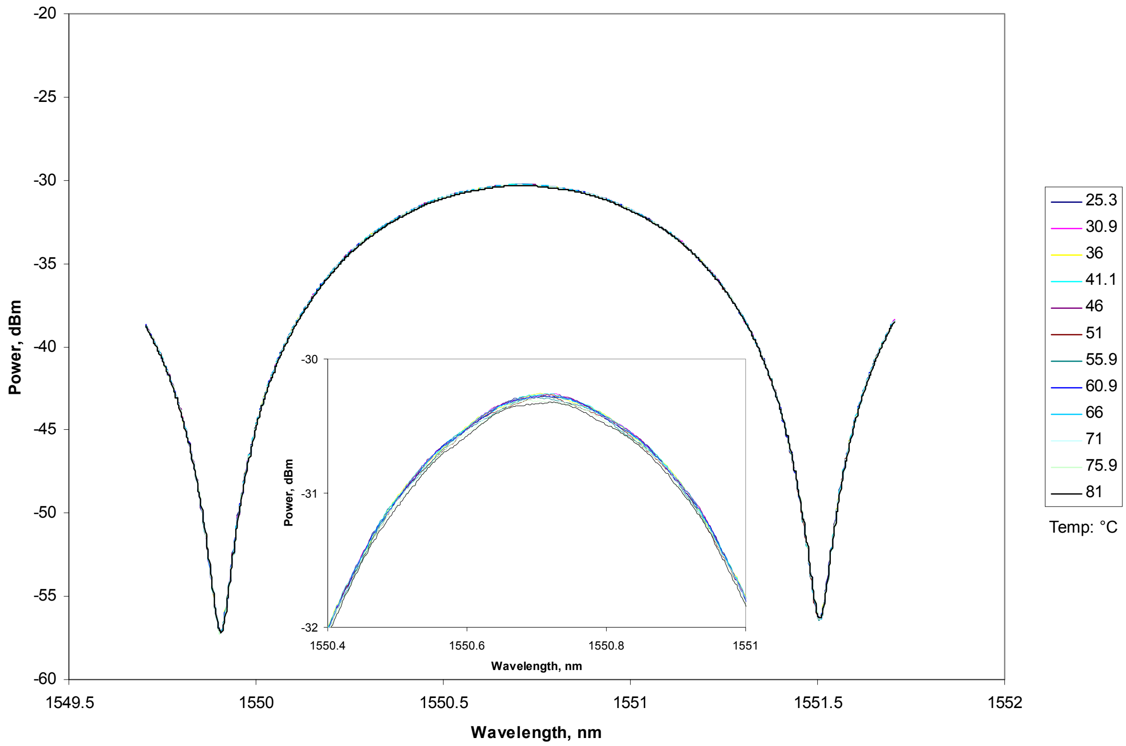
To demonstrate the temperature stability of the optical rotator, a TeO_2 crystal cut for 60° rotation at 1550 nm was placed in an oven. A YVO_4 wavelength filtering element combined with a temperature-compensation crystal were placed external to the oven with an output polarizer oriented orthogonal to the light polarization at the TeO_2 rotator output (and thus the crystal pair input). Tunable, polarized light was passed through the rotator, crystal pair, and output polarizer. The passband of the crystal pair (shown below) was measured with an HP86142B Optical Spectrum Analyzer as the TeO_2 crystal temperature was varied from 25 to 81°C. The inset graph shows an expanded view of the transmission peak. Note that the passband peak transmission and shape remain nearly unchanged over a 56°C temperature change.



<u>References</u>

1. N. Uchida, "Optical properties of single-crystal paratellurite (TeO_2)," *Phys. Rev. B* **4**(10), 3736-3745 (1971).

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