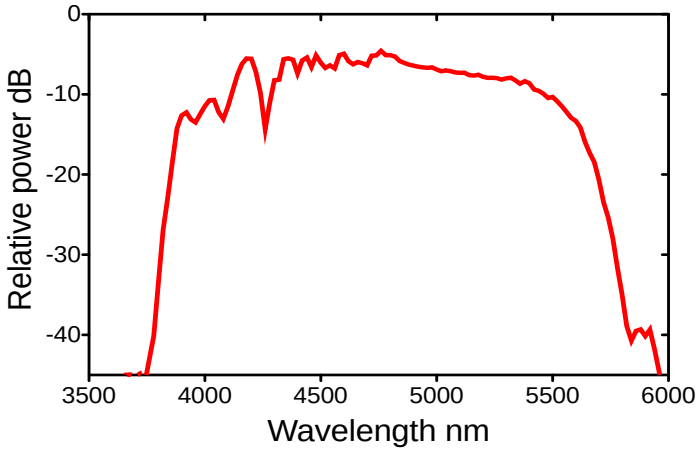
HOTLIGHT SYSTEMS ™

Application Note #2
Broadband, compressible output from MIROPA

Generating pulses only a few optical cycles long in the mid-infrared is a significant technical challenge and generally requires quite complex, large, and expensive laser systems. MIROPA offers an alternative and straightforward approach based on the creation of a chirped output pulse by normal dispersion self phase modulation followed by a simple non alignment critical bulk optics compressor.

In most instances the dispersion of a material in the mid-infrared (MIR) is anomalous because MIR wavelengths lie closer to the vibrational absorption bands than the electronic bandgap. However, for materials that have very low photon energy, such as Chalcogenide glasses, the material dispersion up to around 6µm remains normal and can be relatively small. Furthermore the high third order optical nonlinearity of the Chalcogenides means that an ultrashort pulse travelling through the glass will be spectrally broadened primarily by self-phase modulation and this combined with normal dispersion can lead to an output pulse with a near linear chirp that can be easily compressed to a duration considerably below that of the input pulse. Few cycle pulses can therefore be generated from MIROPA quite simply.

To employ this technique with MIROPA, a waveguide geometry is necessary to attain sufficient intensity. The net dispersion of a waveguide is different to the bulk material due to waveguide dispersion (generally anomalous). However with low index contrast the waveguide dispersion can be very small meaning that the material dispersion remains dominant. This is the case for some commercially available chalcogenide optical fibers. Our tests have shown that the insertion loss for MIROPA operating in the 3-5µm band can be less than 3dB using these fibers and that >100mW average output power can thus be delivered to the fiber output. An example of the achievable spectral broadening is shown below.



Here a 320fs duration input pulse with approximately 100nm spectral bandwidth was increased in bandwidth to > 1100nm at -3dB points. In this spectrum the strong dips around 4.2µm are due to absorption by CO_2 in the atmosphere. In this demonstration the fiber is too long to be compressed but by shortening it to only a few cm, a compressible chirp yielding a sub-50fs pulse is predicted with a simple bulk optics compressor. This offers a simple and robust approach to obtaining few cycle optical pulses in the 3-5µm band. Such a source can also be used as a very high brightness broadband source for spectroscopic CO_2 isotopic detection for example where very high signal to noise ratios are required with highly collimated beams for stand off detection. We are currently engineering this option to fit inside the existing MIROPA case to offer to customers as an option in the fourth quarter 2016.

For further information contact a Hotlight Systems technical representative at contact@hotlightsystems.com