Note that whilst the srs-network contains a 3-screw axis of opposite chirality along [111], our numerical simulations have not shown the formation of bandgaps or polarisation stop bands in this direction.

5. Experimental setup

The fabrication of these 3D networks was achieved by the DLW method. A beam of femtosecond pulses (~150 fs) operating at a wavelength of 580 nm was focused by an oil immersion objective (Olympus, N.A. 1.4, 100X) in the commercial photoresist IP-L (Nanoscribe Gmbh). The 3D networks were written by the 3D translation of the photoresist mounted on a piezoelectric translation stage (P-562, Physik Instrumente). The srs-networks were built starting from the substrate using a layer-by-layer approach to ensure mechanical stability of the network at all times during fabrication.

Experimental characterization of the transmission spectra were performed by using a Thermo Nicolet Fourier-transform infrared spectrometer in conjunction with an infrared microscope (Continuum). Circular polarization analysis was achieved by using a combination of a ColorPol MIR polarizer and a Bernhard Halle achromatic MgF_2 quarter-wave plate. Transmission spectra were normalized relative to the transmission through the silica substrate. A pinhole was used in front of the microscope objective to reduce the full opening angle of incident light to 10° and the sample was mounted such that the light was incident along the [100] axis (in the vertical direction).

6. Conclusion

In conclusion, we have fabricated and characterized a range of novel biomimetic photonic chiral composites, inspired by a recent finding in butterfly wing-scales. These 3D srs-networks have cubic symmetry, are geometrically chiral, fully interconnected and have robust mechanical strength providing an excellent platform for the design of chiral metamaterials, chiral PCs, integrated quantum optical chips and ultrasensitive biosensors. We have experimentally and numerically characterized the transmission spectra of these microstructures showing strong circular dichroism (or lack of) within these chiral (achiral) composites. Further engineering of the composition of these networks will lead to novel photonic devices such as circularly polarized beam splitters and superprisms that could be integrated onto an optical chip.

The srs-network is the simplest chiral network; in fact it is the only degree-three network with symmetrically identical vertices and edges [36]. Thus the srs-network is suitable important for the scaling down of these complex cubic networks for shorter wavelength operation. Scaling of the unit cell size to achieve active wavelengths in the telecommunications regime of 1.5 µm should be achievable with standard high-resolution DLW methods.

Acknowledgments

We thank Stephen Hyde for help with the multiple network geometries. We thank Michael Thiel for providing the SEM images of the Callophrys Rubi. This work was produced with the assistance of the Australian Research Council (ARC) under the Centres of Excellence program. CUDOS (the Centre for Ultrahigh-bandwidth Devices for Optical Systems) is an ARC Centre of Excellence. Mark Turner acknowledges the Australian postgraduate award and CRC for Polymers for funding. Gerd Schröder-Turk gratefully acknowledges the support of the Cluster of Excellence 'Engineering of Advanced Materials' at the University of Erlangen-Nuremberg, which is funded by the German Research Foundation (DFG).

#145057 - $15.00 USD Received 30 Mar 2011; revised 4 May 2011; accepted 5 May 2011; published 6 May 2011