2021 Conference on Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC) | 978-1-6654-1876-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/CLEO/Europe-EQEC52157.2021.9541786

Enhanced transparency in strongly scattering media

Alfredo Rates[1], **Allard P. Mosk**[2], **Ad Lagendijk**[1], **Willem L. Vos**[1]

1. Complex Photonic Systems (COPS), MESA+ Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500AE Enschede, The Netherlands

2. Debye Institute for NanoMaterials Science and Center for Extreme Matter and Emergent Phenomena, Utrecht University, Princetonplein 5, 3584 CC Utrecht, The Netherlands

The well-known optical theorem describes that extinction energy lost from a light beam is equal to scattering in all directions, and possible absorption [1]. Recently, our group has generalized the theorem to multiple incident beams [2], with which we discovered it is possible to either enhanced transparency or enhanced extinction in a scattering system with multiple beams, controlling the relative phase and angle between them. This effect is called mutual transparency or extinction. Here, we present an experimental study of this effect. We use a strongly scattering sample made from a strip of silicon (see figure 1.b). A liquid crystal phase retarder is used to control the phase difference between two incident beams and using an unbalanced March-Zehnder interferometer, we can control the relative angle with a movable mirror.

For small angles, we can almost duplicate the total extinction or nearly annihilate it. In Figure 1.a a curve of total extinction against the relative angle is shown. As can be seen, the experimental data closely follows the theoretical model [3]. We investigate the phase and also angle dependency of the total extinction and how the Fraunhofer diffraction model compares to our exact calculations. Our technique has the potential to control both forward and backscattering on a sample.

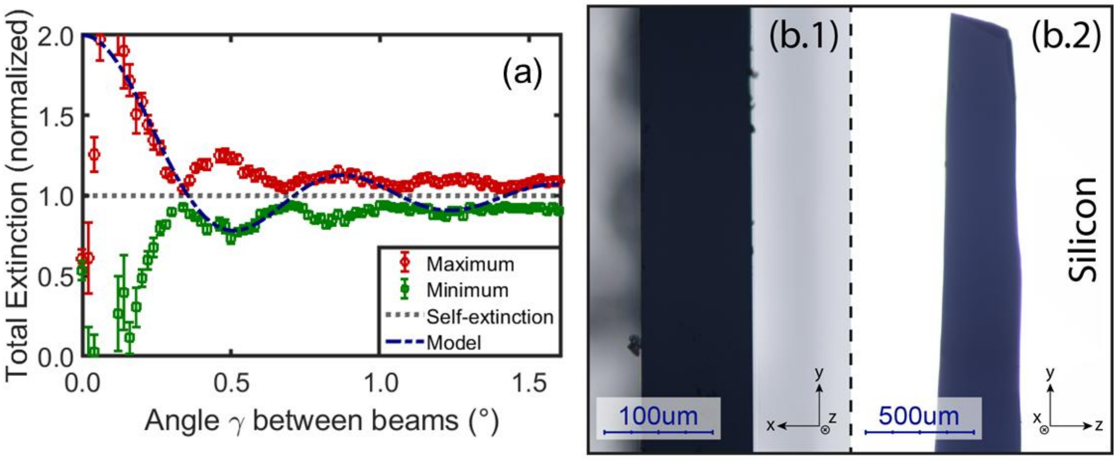

Fig. 1 At the left, (a) total extinction of the silicon sample while changing angle. Red circles are the maximum extinction obtained while changing phase, green squares are the minimum extinction while changing phase. At the right, microscope pictures of the silicon sample (b.1) from the side and (b.2) from the top. The thickness of the sample is measured as $d = 102 \pm 1\ \mu$m.

References

[1] M. Gustafsson, K. Schab, L. Jelinek, and M. Capek. “Upper bounds on absorption and scattering”, New J. Phys. **22** 073013 (2020)
[2] A. Lagendijk, A. P. Mosk and W. L. Vos, "Mutual extinction and transparency of multiple incident light waves," EPL **130** 34002 (2020)
[3] R. G. Newton in, “*Scattering Theory of Waves and Particles*”, (Springer Heidelberg, Berlin, 1982).