rings, as well as in new FELs typified by the FERMI facility⁶ and the LCLS-II soft X-ray FEL at the Stanford Linear Accelerator Center. The exploitation of these new methods is strongly anticipated in the soft X-ray imaging community⁴. Beyond this, of course, one would wish for a similar toolkit for use at hard X-ray wavelengths; here the downscaling of nanofabrication of diffraction optics makes extending the work of Lee and co-workers difficult. At even shorter wavelengths, typified by sources based on inverse Compton scattering, the

unequivocal measurement of OAM X-ray properties based on scattering of an OAM optical beam is challenging. There are numerous fundamental physics questions to be resolved in this scenario, including the role of the incoherent scattering process in creating a mode with non-trivial OAM⁷. □

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OPTICAL WAVEGUIDES

Assembly by light

On exposure to two counter-propagating light beams, small polystyrene beads suspended in water can self-assemble themselves into optical waveguides. That's the finding of Oto Brzobohatý and co-workers from the Czech Academy of Sciences, Czech Republic (*ACS Photonics* <https://doi.org/10.1021/acsp Photonics.8b01331>; 2019).

The team used the approach to create colloidal waveguides (CWs) from a one-dimensional chain of 16 identical polystyrene spheres (657 nm diameter). The assembly process and spatial arrangement of the spheres is driven by the combination of optical gradient forces and long-range scattering forces. Interestingly, the waveguide was found to have a graded refractive index profile along both its length and width (lateral and transverse index variation).

The optical characteristics of the waveguide were investigated by sending in a wavelength-tunable probe beam from a white-continuum laser that was spectrally filtered by a monochromator and tunable from 450 nm to 2,200 nm. The intensity of the probe beam at the CW location was approximately three orders of magnitude lower than that of the trapping beams. Depending on the experimental conditions (wavelength of probe light, spacing of the spheres), the probe beam is either guided or deflected by the spheres.

Credit: American Chemical Society

The spatial arrangement of the polystyrene spheres in the CWs was controlled by the cooperation of optical gradient forces — originating from the spatial gradients of optical intensity of the counter-propagating trapping beams — and long-range optical forces mediated by the photons scattered from the spheres. By simply adjusting the spatial profile of the trapping beams, the mean interparticle spacing was tuned, which led to modification of the effective refractive index of the CWs. When the index increased due to the decreased spacing of the spheres, the deflected mode was shifted towards longer wavelengths.

Once the deflecting mode started to approach the trapping beam wavelength at 1,064 nm, the structure of the CW started oscillating. Since the trapping

beams were deflected off the CW axis, the confinement of the polystyrene beads was momentarily lost, and the CW structure briefly fell apart due to Brownian motion. However, as soon as the structure lost its form, its effective refractive index changed and the trapping beams could again propagate through the structure, which led to restore the original structure.

“Among the potential applications of this feedback/modulation scheme, one can envision spectral-mode filtering in hollow-core photonic fibres using CWs self-arranged in the fibre core”, Brzobohatý said. □

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