Electronic Supplementary Material (ESI) for Soft Matter

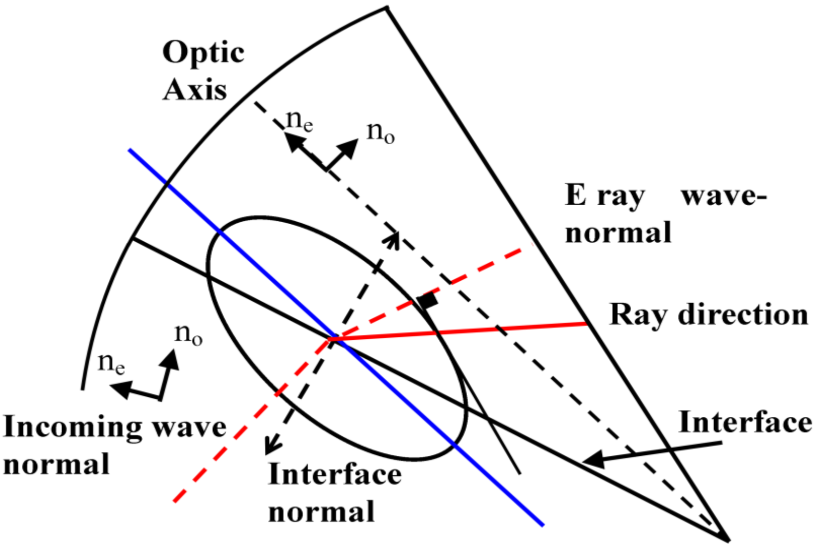
Giant Amyloid Spherulites reveal their true colours: supplementary information

M.I. Smith[1], J.S. Sharp[1,2] & C.J. Roberts[2,3]

1) Modelling the spherulite as a 2D disc:

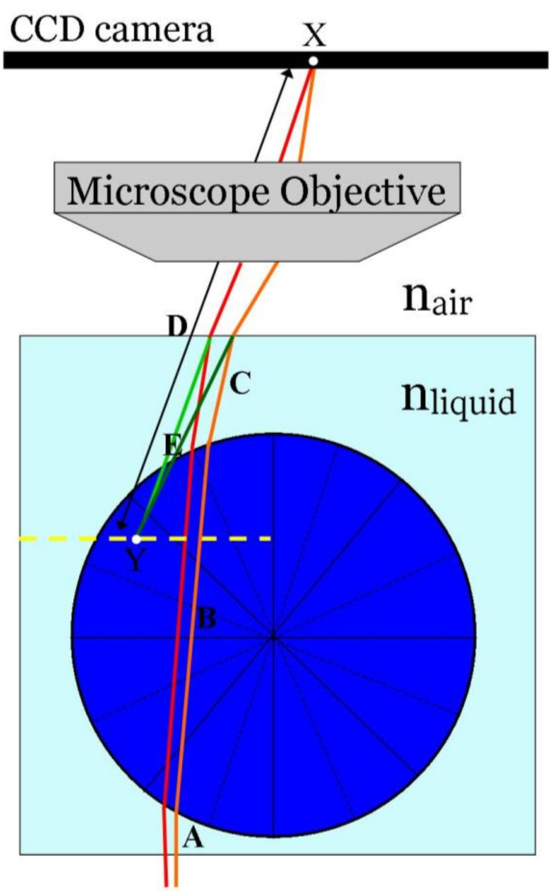
A ray entering the spherulite with wavevector ($\mathbf{k_i}$), the spherulite normal (**N**) and refracted ray ($\mathbf{k_r}$) all lie in the same plane ($\mathbf{k_i} \times \mathbf{N}$). Since this plane also includes the centre of the spherulite it follows that for each ray there is a 2D disc, like that shown in figure 3. The extraordinary refractive index also lies in this plane. Consequently, refraction of the extraordinary ray is similarly confined to the same 2D plane. As a result the ray tracing problem can be reduced to two dimensions. After calculation this plane can be rotated around the vertical axis to recover the full 3D spherulite.

2)



Supplementary figure 1. At each interface we calculate the effective refractive index in the next segment and the direction of propagation of the ray and its wave normal. Since the optic axis of each segment is different the extraordinary ray refracts at each segment boundary, resulting in a slightly curved path through the GAS. ne is the extraordinary refractive index, no is ordinary refractive index.

3)



Supplementary figure 2: Schematic diagram showing the path of an ordinary and extraordinary ray through the spherulite which interfere at the CCD camera at the point X. The polarisers have been removed to aid clarity.

Calculating the path difference between an ordinary and extraordinary ray which meet at a point (X) on the CCD camera is done in the following way. Firstly, we know that there is a virtual image formed of that point, from which an extraordinary and an ordinary ray both *appear* to have come, at Y. Imagine a point source in air at this point. Rays from this point would be focussed to a point on the CCD camera. Consequently, it follows that the path length for any pair of rays between these two points assuming they travel only through air will be equal. It is also true that the two component polarisations entering the liquid at the bottom of supplementary figure 2 will also be in phase. The total path length for each of these rays is therefore:

Pathlength 1 = A + B + C +(D – E)

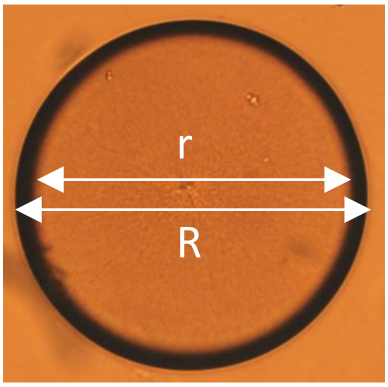
Pathlength 2 = A' + B' + C' + (D' – E')

However, from our earlier argument D=D'

Therefore the total path difference = (A + B + C – E) – (A' + B' + C' –E')

4) Estimating the refractive index and birefringence of spherulites.

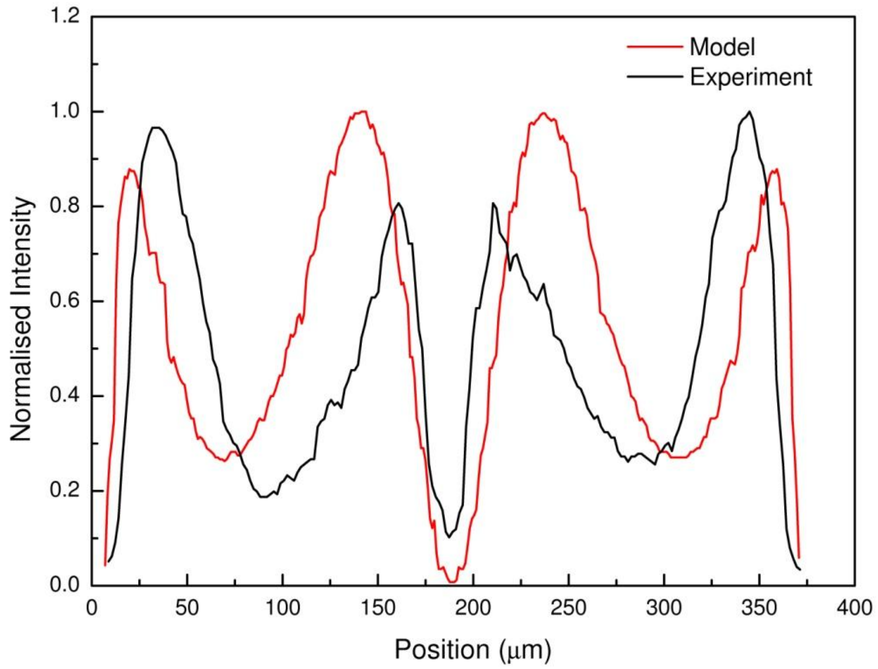
Refraction results in an image with radius (r) less than the spherulite radius (R). Supplementary figure 3 shows an image of a GAS obtained without crossed polarisers. The exact size of this image is set by the numerical aperture of the microscope objective the refractive index of the liquid and the mean refractive index of the spherulite. Knowing the refractive index of the liquid we match the image radius produced using our model by iteratively changing the mean refractive index of the spherulite. This method is accurate so long as sufficient refraction takes place. Therefore only the first 3 data points are estimated in figure 3b of the manuscript.



Supplementary figure 3: Image of a GAS obtained with a x10 objective without crossed polarisers. The radius of the image r relative to the spherulite radius R can be used in conjunction with the model to estimate the mean refractive index of the spherulite.

In order to estimate the birefringence (dn) we choose the image of the spherulite collected with a 530nm narrow pass filter. We then minimise the fringes in our model to match it as closely as possible by varying dn. As mentioned in the main text, some systematic differences are observed in the fringes which are likely to be due to the assumption of uniform density throughout the spherulite. However, we expect the birefringence values obtained to be close to the real values.

Electronic Supplementary Material (ESI) for Soft Matter



Supplementary figure 4: An estimate of the birefringence is made by minimising the line profiles of the model to match the experimental images in different refractive index liquids.