UNIVERSITY OF LEICESTER

Optical trapping and its applications for liposome research

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Optical trapping

Optical trapping is a process where a tightly focused laser beam can isolate a single nanometer to micron sized droplet. When the laser beam interacts with the droplet the droplet refracts some of the light, due to photon pressure this creates a force pushing away from the laser, however to preserve momentum a balancing force is created pushing the droplet towards the beam. This means that the droplet becomes fixed in the focus of the beam.

A photodiode can be used to measure laser light reflected by the droplet. This is useful because it allows for very high speed changes in the droplets morphology to be studied by looking at the behavior of the reflected light.

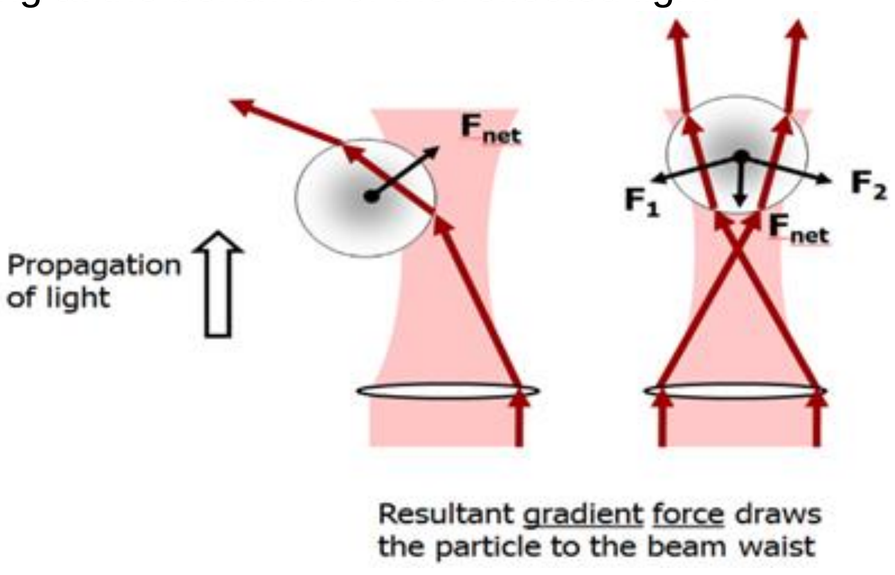

Figure 1 – An optical trap.

Liposomes

A liposome is a spherical structure consisting of a fluid encapsulated by a bilayer made of the same material as a cell membrane. Liposomes range in size from nanometres to several microns.

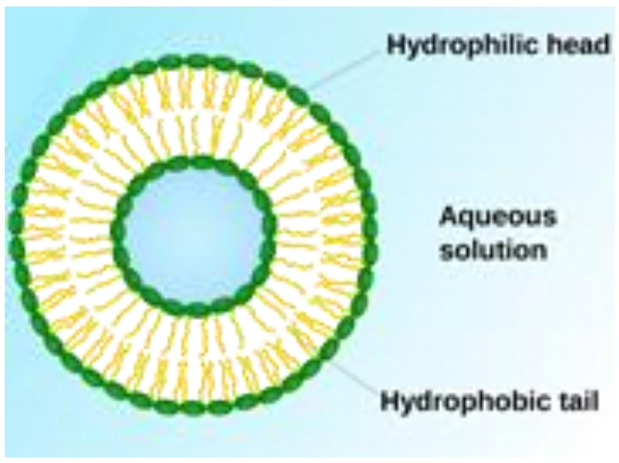

Figure 2 – A liposome.

Liposomes have several applications in medicine, one of which is that they can be used to encapsulate drugs which can then be administered to a patient. When liposomes are heated past a certain temperature the membrane undergoes a change from a gel like state to a liquid state. During this transition the release some of their encapsulated interior solution.

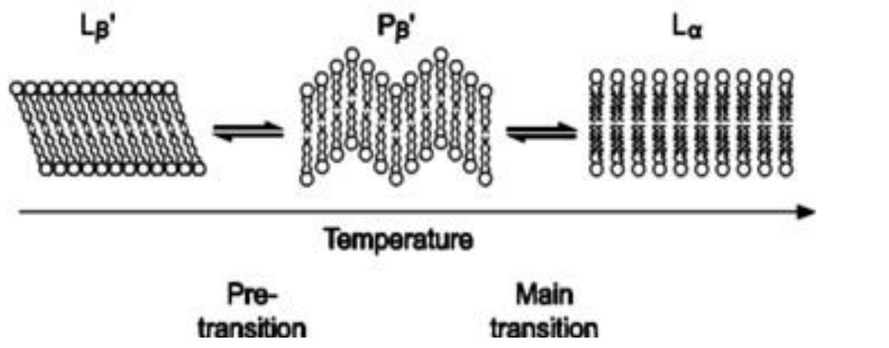

Figure 3 – A liposomes temperature transition. As the liposome transitions the tails switch from being compact and ordered to being loose. Image taken from [1].

Results

Using optical trapping a single cell liposome was held and then heated towards its transition temperature. The reflected light was recorded using a photodiode.

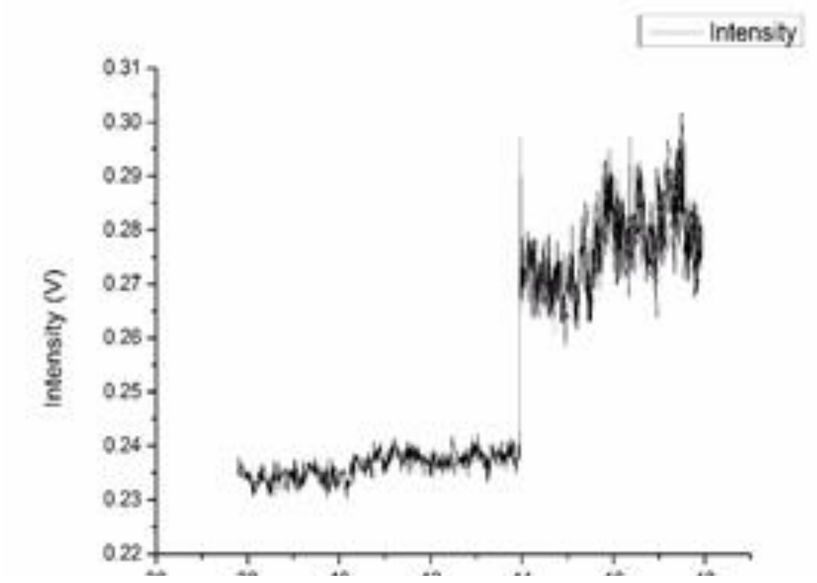

Figure 4 – Low resolution light scattering from the liposome against temperature..

As figure four shows the transition occurs over one data point the experiment was run again with a higher time resolutions. This allowed us to measure the time for an individual liposome to transition.

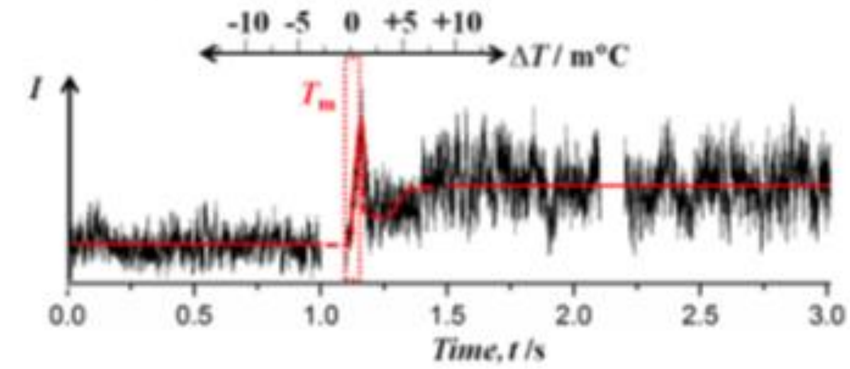

Figure 5– High resolution light scattering from the liposome against time.

The experiment shows the extreme sharpness of the transition for an individual liposome. In the high resolution data the transition is observed over 60ms which corresponds to 0.002 °C. This is far quicker than other experiments have shown the transition of the bulk sample which occurs over 1 °C.

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[1] Phase transition temperatures for glycerophospholipids, http://avantilipids.com/ , Avanti polar lipids, 2016

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