MINA HEALEY: Hi. My name is Mina, and I'll be teaching about liquid crystals. Liquid crystals have a wide variety of applications in modern technology and science, and this is because of their unique structure. They flow like conventional liquids but are arranged in a similar way to crystalline solids. Liquid crystal molecules can be calamitic or rod shaped. They can also be diskotic, or disc-like.

In this video, I'll be talking about calamitic liquid crystals. Smectic liquid crystals are arranged in a layered structure and have long range orientational order and one-dimensional translational order. Pneumatic liquid crystals have no long range positional order but have long range orientation order. One way to characterize a liquid crystal is with its orientational order parameter.

n is the director or the vector which points along the preferred axis of the liquid crystals' molecular orientation. p is the non-polar vector which indicates the orientation. Theta is the angle between the n and p vectors. The general equation for the orientation, all order parameter is s is equal to 2 times the average of n dot p squared minus 1.

An isotopic liquid would have an s of 0 because theta would be random. But over the average of all the thetas, n dot p squared would be 1/2. A perfect crystal has an s of 1 because n is parallel to p. The orientational order parameter for liquid crystals lies somewhere between 0.3 and 0.9 depending on temperature.

Another descriptor of liquid crystals is the translational order parameter. Sigma is used to describe the layering in smectic liquid crystals. In this equation, z is position and a is the distance between layers. Sigma is the average of the periodic function 2 pi z over a.

Many devices that use liquid crystals such as liquid crystal displays or LCDs in TV'S rely on the specific orientation of the liquid crystal molecules in a sample. To be able to do this correctly, we need to know the energy required to reorient the molecules in a specific liquid crystal. To reorient the molecules in a liquid crystal, we have to apply a voltage to the sample and observe when the molecules have aligned.

To be able to find the energy it takes to reorient a molecule in an electric field, we need to use the equation for an electric field-- e equals v over d, with v being the voltage applied and d being the distance across which the voltage is applied. We also need the equation of the energy of rotation. This is derived from the torque equation-- tau equals e cross mu.

The energy of reorientation is u equals e times mu times 1 minus cosine of theta, with mu being the dipole moment of our sample and theta being the angle between the unrotated molecule and the direction of the electric field. In this example, the liquid crystal experimented on is 5cb. The observed switching voltage is 16 volts.

The spacing is 2.5 times 10 to the negative fifth meters. The dipole moment is 4.9d multiplied by 3.3 times 10 to the negative 30. And pi over 2 is the average of all the angles in the sample.

Plugging these values into our equation, we can see that the energy of reorientation for the liquid crystal 5cb is about 6.2 joules per mole. What we are now looking at is a visualization of the liquid crystal becoming ordered as an electric field as applied. As you can see, when the voltage increases above the switching voltage, the liquid crystal becomes more and more ordered. Liquid crystals are used in many new technologies, and learning about their structure is very important. I hope you enjoyed this video and learned some new things about liquid crystals.