1.

This experiment is carried out in the first semester of the second year. Our instructor, Professor Cao, proposed that there are interactions between the amino-group and Maleimide. Besides, the bond between them could be weak and reversible.

2.

As we are sophomore and major in physics, we try to solve this single molecule issue by using our knowledge about mechanics. With the help of our upperclassman, we acquainted with the idea to use hydrogel property measurement to predict the characteristic of the single chemical bond. We chose the BSA protein and the 4arm-PEG-Mal to form the hydrogel. The BSA protein has a molecular weight about 60000, and have many amino-group on its surface. Besides, the 4arm PEG-Mal have a molecular weight about 20000, for each arm it’s 5000. When the PEG-Mal reacts with the BSA protein, they form a complex 3D network capable of forming a hydrogel.

3.

However, the synthesizing process didn’t go on smoothly. The reaction between the amino-group and Maleimide in PBS buffer is so slow that it takes 24 hours to form the hydrogel. What’s more, for precisely measurement, the shape of the hydrogel must be cylinder. In this case, my partner and I came up with the idea to use syringe as the vessel. As you can see on the picture. We sucked the mixed-liquor in to the syringe, put the syringe in the oven for 24 hours, before cut it off to get the column-like gel.

4. As for the measurement. We used tension machine and rheometer to test the elasticity and viscosity of the BSA-Mal hydrogel. The result is shown in the pictures.

From the Force – Strain curve, we can see the hysteresis(迟滞) phenomenon. Which means the pressure from the hydrogel during the pressing period and the recovery period is different. We know that area on the force – deformation curve means energy absorbing or releasing. In this case, it clearly that the hydrogel absorb energy in the pressing cycles.

Through our analysis, this phenomenon could result from the energy absorption of breaking the amino-Maleimide bond. But it could also result from the deploy of huge BSA protein. To test that, we set up our control group, replaced the PEG-Mal with PEG-SG, which would from strong bond with amino-group (wouldn’t break under pressure). The testing group also showed the hysteresis phenomenon. According to our calculation, the energy absorbed by BSA-Mal gel is slightly larger than the BSA-SG gel. But we still need further study to conform that the amino-Maleimide bond is reversible.

We further tested the self-healing ability of the BSA-Mal hydrogel. If the interaction is reversible, it must can heal the cracks in it. The gel with cracks is submerge in the PBS buffer after the force spectra measurement. If the force the gel generated at the same strain increased after the soak process, then we can determine there is self-healing existed. However, we never saw that happen.

Besides the elastic measurement, we also conduct test toward the viscosity of the BSA-Mal hydrogel. The frequency-pressure curve given by rheometer is showed. As we can see from the graph, value of the storage moduli and loss moduli are close together. So, the BSA-Mal gel is viscoelastic and quite sticky.