Fabrication of Photo-Responsive Nanospheres as Vehicles for Controlled Drug Delivery

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Introduction

A special type of photo-responsive nanoparticles was fabricated by Xiao et. al based on molecular self-assembly.[1] In their study, a new method based on ionic self-assembly technology was provided to prepare polymeric hollow nanospheres with azo functional groups. These nanoparticles can change the shape from sphere to ellipsoid when exposed to linearly polarized visible light, due to the presence of azo-dye moieties. The azo-dye molecules can transform from trans- to cis- conformation under irradiation of visible light. Such a shape change can provide a unique controlling mechanism for drug delivery (e.g., controlled delivery rate) to targeted cells (such as cancer cells). However, this special type of photo-deformable nanoparticles has not yet been tested for drug delivery.

Materials and methods

The first step of my project was to design and synthesis Pan-stat-P4VP random copolymer which was composed of 4-vinylpyridine and acrylonitrile. The graph below is the equipment to synthesize the copolymer. The florescent azo dye was added to the copolymer after synthesis. Then, the copolymer was used self-assembly to form the hollow nanosphere as the drug delivery vehicles. [2] Last step was to observe the diffusion rate under the fluorescent microscope after the laser treatment.

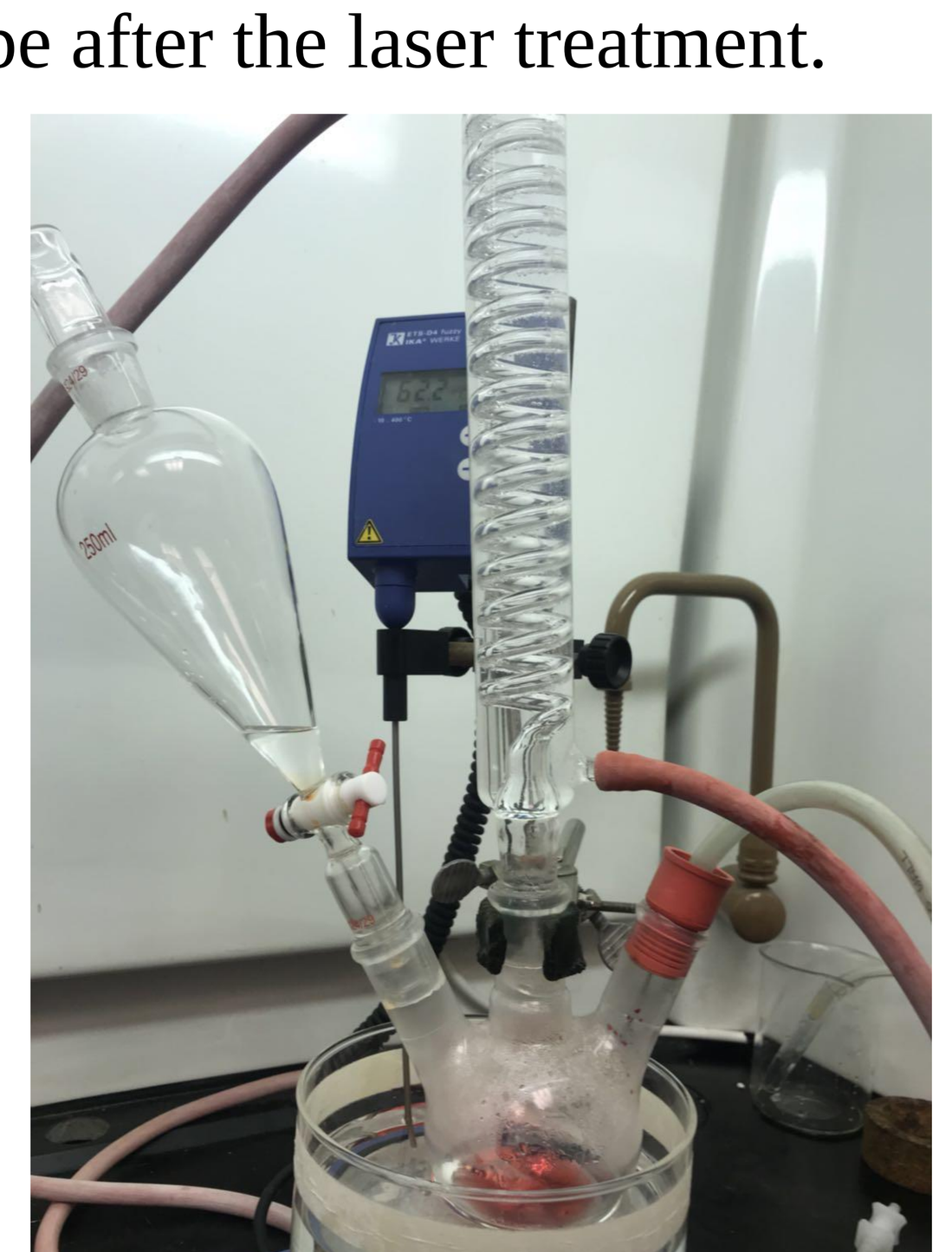

Figure 1. Chemical synthesis setup.

Results

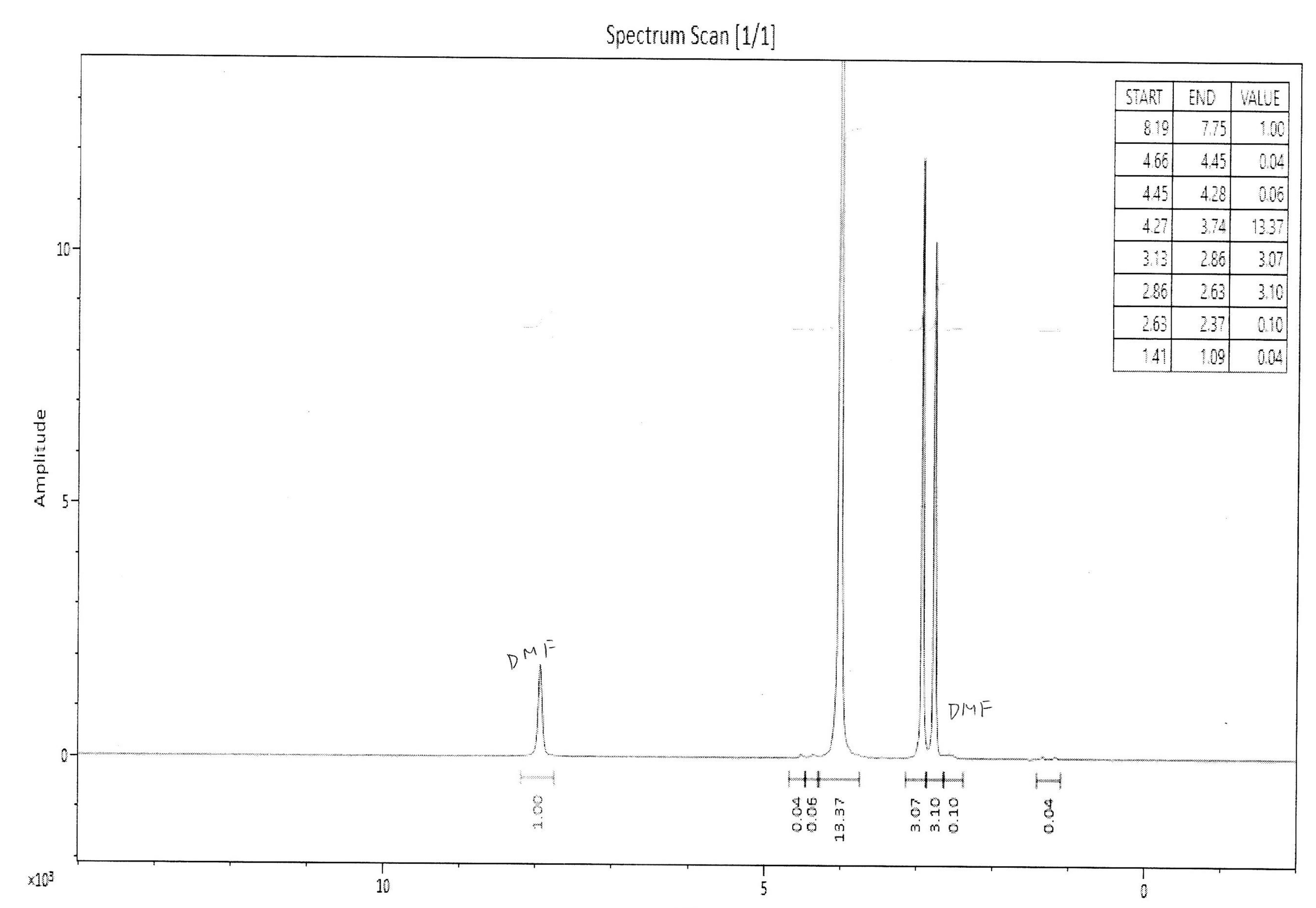

Figure 2. H-NMR Spectrum of the Nanosphere.

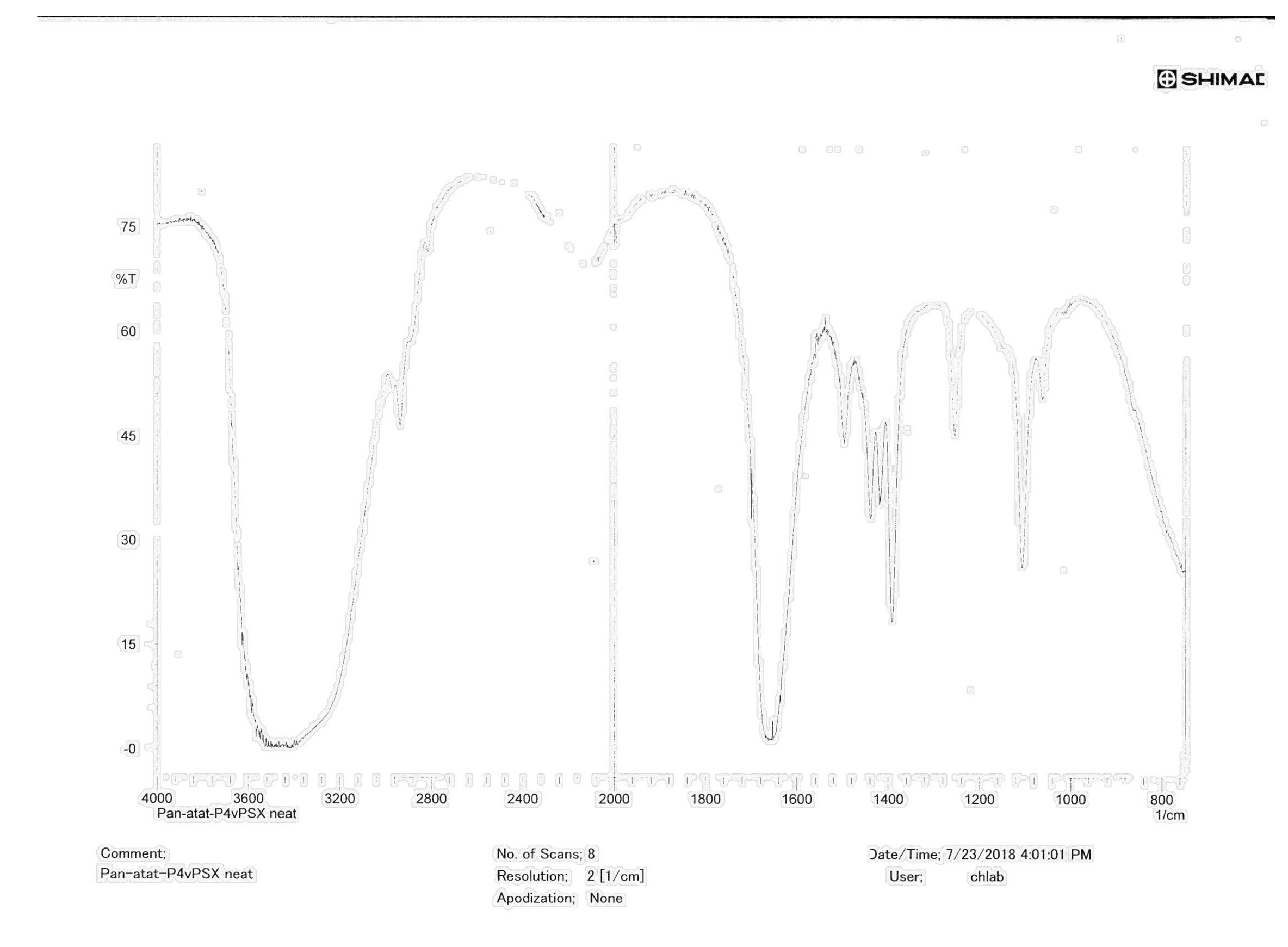

Figure 3. IR Spectrum of the Nanosphere.

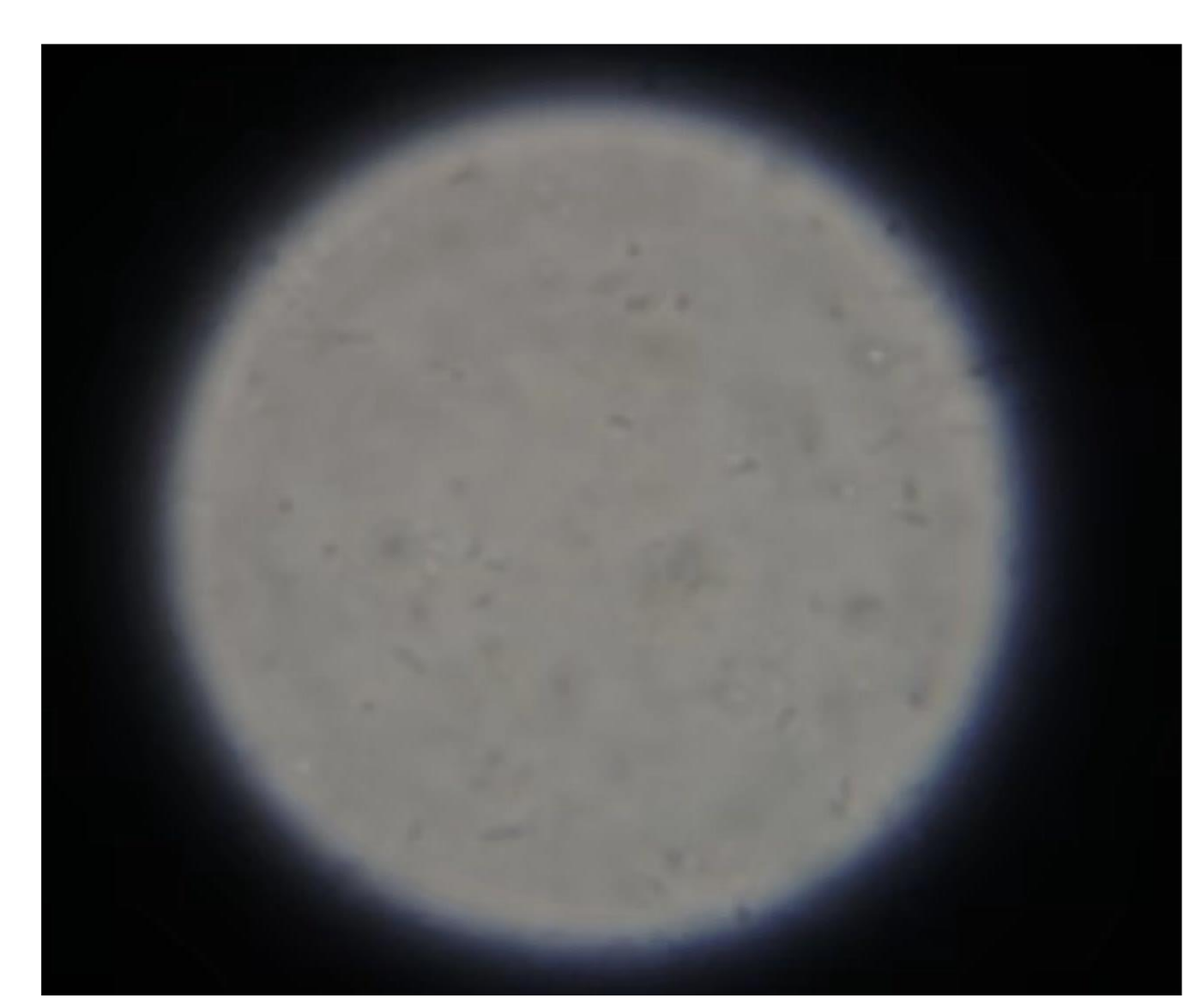

Figure 4. E. coli cells after one hour polarized laser light treatment.

The E.coli was still alive (keep moving) after the laser light treatment. Therefore, the laser light will not kill the E.coli bacteria at room temperature.

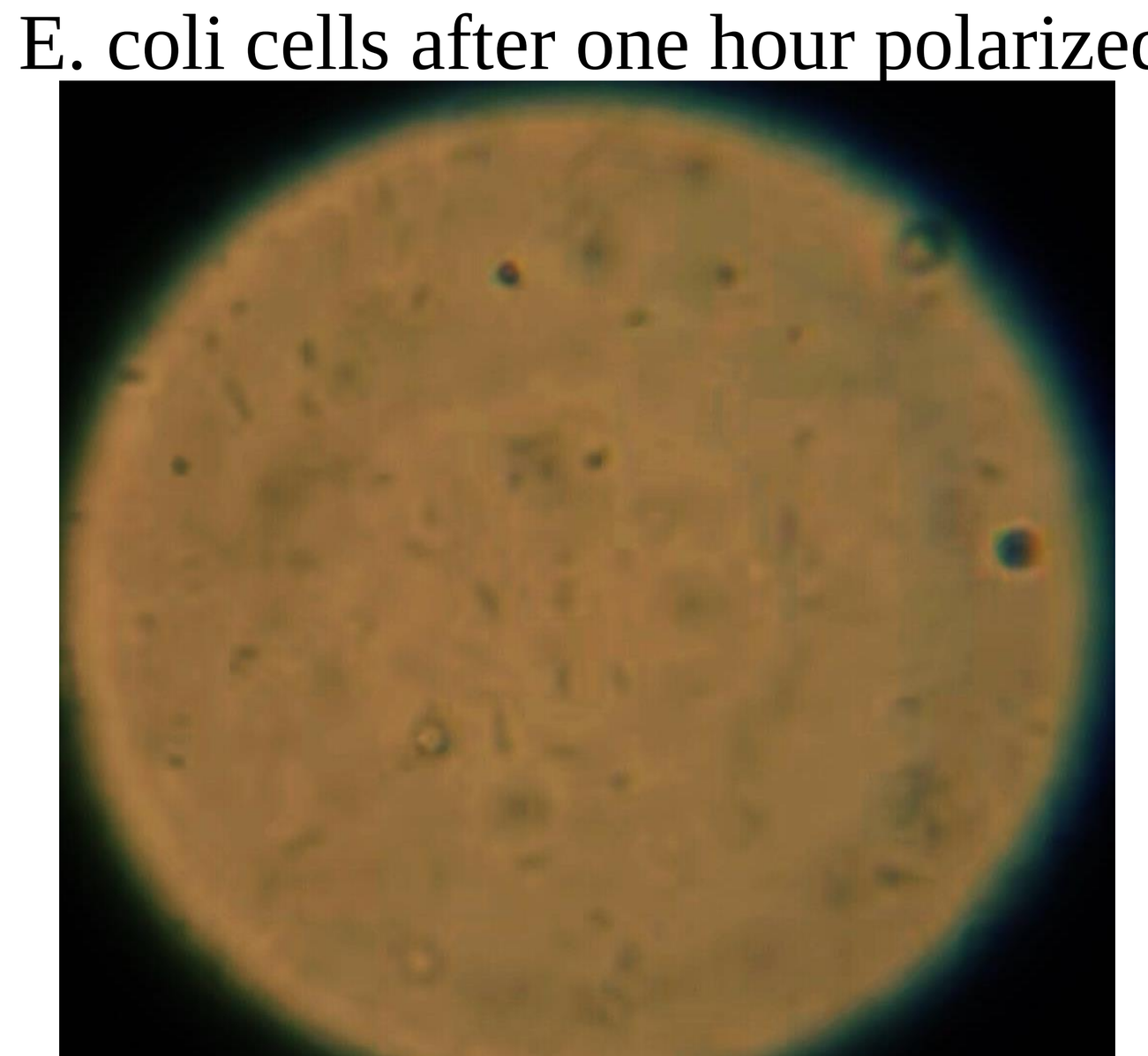

Figure 5. E. coli with nanosphere under the florescent microscope.

The graph above was edited to show the clearer results. The original one was pictured under the red florescent light.

The florescent azo dye (SAS and MY) did not work well as expect. The computer showed that it could not capture the florescent light from the nanosphere. Thus, the diffusion rate cannot be observed. But I will continue working on it, the new florescent dye will be used for the future step.

Conclusions

1) The E.coli can survive for at least one hour after the polarized laser treatment at room temperature.
2) The MY (metanil yellow) and SAS (sodium antraquinone -2 –sulfonate) did not work as florescent dye during the experiment. The new florescent dye need to be found for the future experiments.
3) The chemical environment (e.g. pH value, temperature, the concentration of the dye etc.) may matter in this case. I will also find the best chemical environment for the future experiment.

Literature cited

[1] Jin, Cheng, Taoran Zhang, Fangzhuan Liu, Lingyu Wang, Qinjian Yin, and Dequan Xiao. “Fabrication of Size Controllable Polymeric Hollow Nanospheres Containing Azo Functional Groups via Ionic Self-assembly.” RCS Advances 4.16 (2014): 8216. Print.

[2] Jin, Cheng, Taoran Zhang, Lingyu Wang, Meiying He, Bo Jian, Dequan Xiao, Qinjian Yin. “Photoinduced Deformation of Hollow Nanospheres Formed by the Self-Assembly of Amphiphilic Random Copolymers and Small Azo Molecules.” RCS Advances 4.86 (2014): 45890. Print.

Acknowledgments

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