Light Induced Moving Molecule

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As technology grows due to the innovation of making devices smaller, the demand for utilizing even smaller objects in the nano-world increases as well. For this reason it is necessary to examine molecules that possess optical mechanical properties in hopes that they will be the new building blocks of the future. Research has shown that the Monorotamer molecule can produce unidirectional rotational movement when powered by UV light. We are interested in using this knowledge to create a light induced moving molecule that could later be applied in nano-scaled machines. We tested this property of Monorotamer by placing molecular samples on a metal surface studied by Scanning Tunneling Microscope and applying UV light in durations of 1 hour and 2 hours. STM images were taken before and after UV light was applied to verify the displacement of the Monorotamer molecules. This procedure was repeated numerous times in order to get accurate comparisons between the before and after pictures that were obtained.

Introduction

- The ability to control the movement of molecules can open the doors to many ground breaking applications in nanotechnology
- UC Berkeley's Department of Chemistry has discovered that UV light can provoke the central double bond present in the Monorotamer molecule to rotate causing the upper group of atoms to move in a circular motion [1]

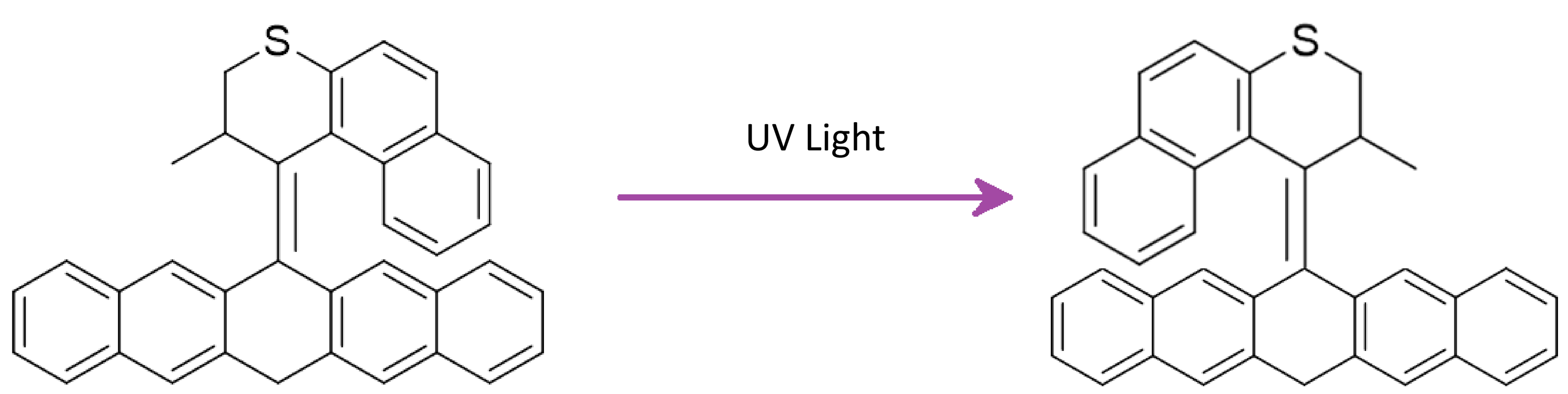


Fig. 1: Monorotamer Molecule before UV light

Fig. 2: Monorotamer Molecule after UV light

- We believe this circular motion can be utilized to make the molecule move on surfaces
- By validating the displacement of this molecule on a metal surface, we look forward to using this molecule as an optically powered motor in nano-scaled mechanical systems

Objectives

- Our goal is to acquire images that show monorotamer molecules moving unidirectional on a metal surface when induced by UV light
- By understanding the mechanical and physical properties of molecules like monorotamer, we hope to assemble them into remote-controlable molecular nanomachines

Experimental Methods

- The monorotamer molecules used for this project were synthetically made and provided by UC Berkeley's Department of Chemistry
- Images of the monorotamer molecules were generated using a STM (Scanning Tunneling Microscope) under ultrahigh vacuum and extremely low temperatures around 13K
- An evaporator was used to evaporate the molecules under the required conditions

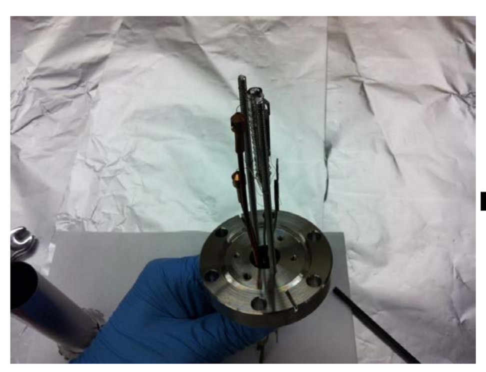


Fig. 3: Inside of Evaporator

Fig. 4: Copper Heat Shield

Fig. 5: Finished Evaporator

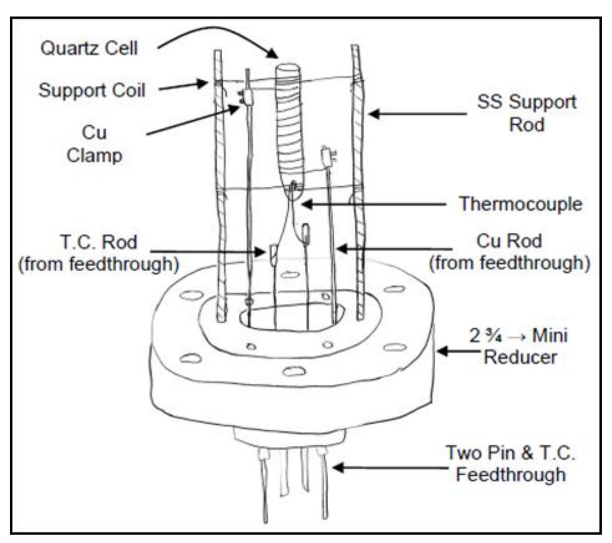


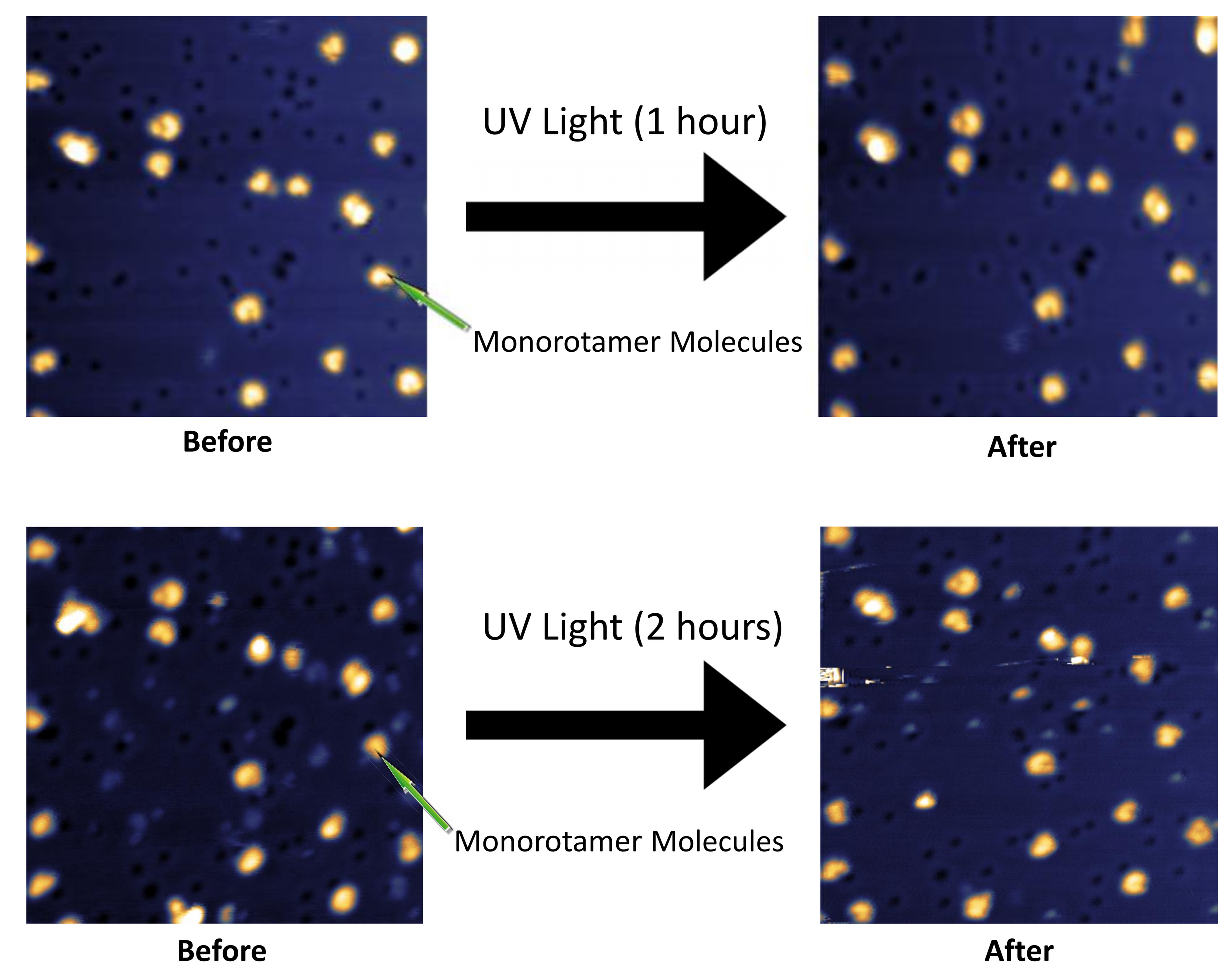
Fig. 6: Schematic of Evaporator

- Once the STM was properly setup, images were scanned before and after UV light was shined on the monorotamer molecules for durations of 1 hour and 2 hours
- These images were then analyzed using the software WSxM to determine if the molecules moved from their original locations

Results

- Multiple before and after images were scanned for this project in which the majority showed the same negative result as seen below:

Fig. 7: Monorotamer on Cu(111) surface
40nm x 40nm



Synthesis: Felix's Group

Conclusion and Future Plans

- Our results tell us that the monorotamer molecule failed to move on top of the metal surface
- We suspect that there are two possible reasons as to why the molecule did not move:
  1. The copper surface used could have altered the properties of the molecule
  2. Not enough light was absorbed by the molecule in order for the central double bond to rotate
- In the future we plan to functionize the monorotamer molecule in hopes that it will absorb more light

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References

1. Ryan Cloke & Felix Fishcher. UC Berkeley Department of Chemistry.

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