# Determining the Location of Brooker's Merocyanine Dye Adsorption to Zeolite L

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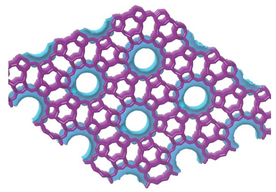
## Abstract

Host-guest systems occur when guest molecules enter the channel of a host material but do not chemically bond together. The guest in this study is Brooker's Merocyanine (BM) dye molecules and the host is Zeolite L. Previous studies have used similar dyes and found that they enter the channels of the zeolite. This study synthesized materials to determine if BM molecules behave the same way, or if the dye molecules are only adsorbed to the surface. The dye-zeolite products were characterized using UV/Vis spectroscopy and powder x-ray diffraction. Based on the x-ray diffraction pattern, it was confirmed we could reproducibly synthesize Zeolite L with minimal merlinoite and sanidine impurities. By soaking Zeolite L in a BM solution, using 2-propanol as the solvent, the dye was adsorbed to the zeolite. This had to be done under specific conditions because BM is sensitive to changes in solvent, light exposure, and pH, which makes it challenging to study. BM solutions were characterized using UV/Vis spectroscopy to determine the optimal dye loading conditions. We found that limiting light exposure in acidic conditions is a key factor to obtain reproducible results. Understanding BM in solution makes it possible to learn more about the BM dye-zeolite system in order to prepare optimal dye-loaded samples. These samples will be characterized through BET analysis, which is used to determine the location of BM in Zeolite L. Studying these interactions can lead to new practical materials.

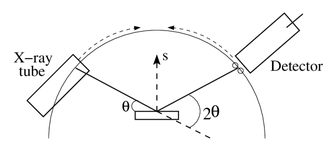

## Zeolite L

- Zeolites are porous crystalline minerals used as chemical adsorbents in many applications such as solar energy storage, and water and wastewater treatment
- Zeolite L is synthesized via a hydrothermal process
- A mixture of alumina, silica, KOH, and water is added to the vessel
- The vessel is heated at 175 ℃ for 72 hours and crystal product is obtained

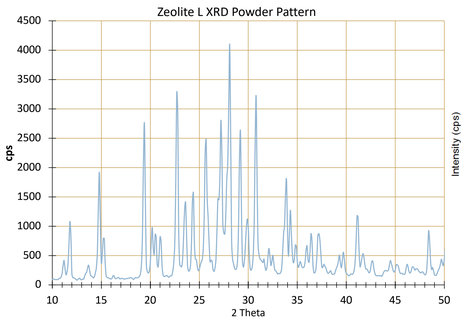


From International Zeolite Association Database

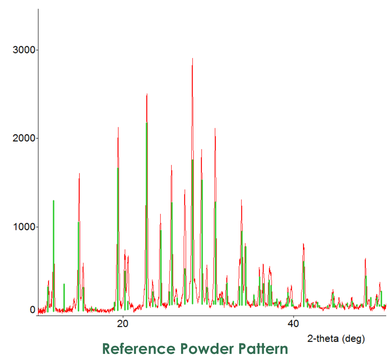
## X-Ray Diffraction



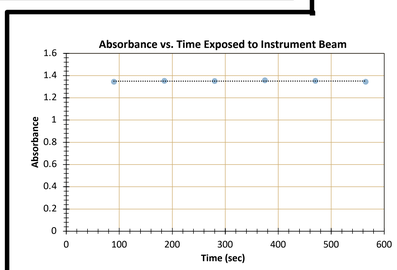

- After we synthesize Zeolite L, the crystals are characterized through X-Ray Diffraction
- We use software to overlay our powder pattern against a reference powder pattern of Zeolite L




Experimental Powder Pattern

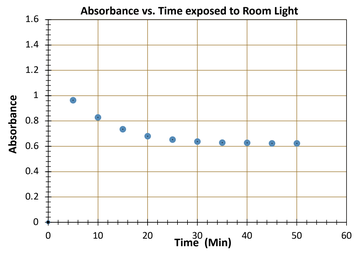



Reference Powder Pattern




❖ **Figure 2:** Study on how the UV/Vis spectrometer affects BM's absorbance

## Light Studies



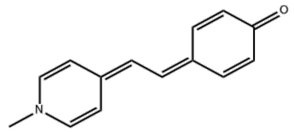

❖ **Figure 1:** Study on how exposure to room light affects BM's absorbance

- Figure 1 shows that the absorbance of the dye solution reacts with room light for about 30 min
- Isomerization causes absorbance to decrease
- To keep consistent results, we need to limit light exposure

- Given the isomerization of BM, the analysis method might also affect dye stability
- Figure 2 shows that the beam of light in the instrument does not affect the absorbance value of the dye molecule

## Brooker's Merocyanine (BM)

- Brooker's Merocyanine is sensitive to changes in solvent, pH, and light
- BM is not known to aggregate in solution
- Similar dye molecules have been adsorbed in Zeolite L



Structure of Brooker's Merocyanine

Figure 4A

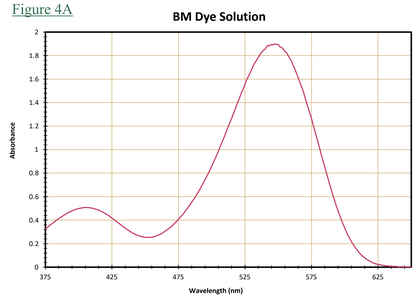
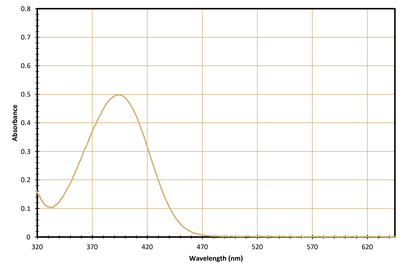



Figure 4B




❖ **Figure 4**: BM dye solution (A) and in acid (B).

- When the oxygen is protonated, the solution goes from a pink color to a light-yellow color
- Further studies are in acid to control the structure of the molecule

## Dye Loading

- Brooker's Merocyanine is loaded into Zeolite L as depicted in Figure 3
- A solution of BM in 2-propanol (left) is mixed with HCl and Zeolite L (right) and is stirred for 24 hours
- The liquid above the zeolite is measured with UV/Vis spectroscopy and compared to a reference solution
- The zeolite absorbance should be lower than the reference indicating dye-loading has occurred

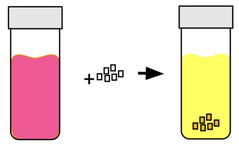


Figure 3

❖ Table 1. Preliminary data recorded in molecules of dye per gram of zeolite

| Current Data | Previous Data |
|---|---|
| $2.46 \times 10^{17}$ | $6.10 \times 10^{17}$ |

❖ These results indicate reproducibility

## Conclusions

- Synthesized multiple batches of Zeolite L with minor impurities
- Confirmed previous data to ensure consistency and reproducibility
- Recorded preliminary results on dye-loaded zeolites
- Preparing dye-loaded zeolites for BET analysis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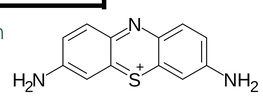
## Thionine Test

- Thionine acetate is a dye that aggregates on the outside of zeolites
- A color change is seen when the dye molecules are inside a zeolite channel versus aggregating on the outside of it



Thionine Structure

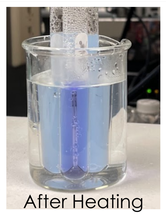
Before Heating

**Test Tubes**

Left/Right: Zeolite L suspension + Thionine solution
Middle: Thionine solution as reference

**Color Change**

Blue Solution: Monomers inside zeolite channel
Purple Solution: Aggregates on outside of zeolite



After Heating

## References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