



**CALIFORNIA SCIENCE & ENGINEERING FAIR  
2018 PROJECT SUMMARY**

<b>Name(s)</b> <b>Juwon Lee</b>	<b>Project Number</b>  38592
<b>Project Title</b> <b>Reflectance Spectroscopy Investigations of Clathrate Hydrates</b>	
<b>Abstract</b> <b>Objectives/Goals</b> The objective of this study is to further study guest-host interactions in clathrate hydrates by analyzing isotopic clathrate hydrates - bromine clathrate hydrates formed from deuterated water. <b>Methods/Materials</b> Produced bromine clathrate hydrates from deuterated water by mixing liquid bromine and deuterated water. Formed clathrate hydrate crystals using an ice bath. Took spectroscopic measurements using fiber optic cables and CCD spectroscopy. <b>Results</b> Two different spectral lines (bromine vs bromine clathrate) were gathered from the spectroscopic measurements. The spectra showed that the enclathration of bromine in the form of clathrate hydrate increased pressure on the bromine, thus causing a blue shift in bromine spectral profile. The blue-shift was observable through the color change from dark red bromine ice to yellowish orange Br <sub>2</sub> -D <sub>2</sub> O clathrate hydrate as well. <b>Conclusions/Discussion</b> A method to produce bromine-deuterated water clathrate hydrates was developed. The direct comparison of the two spectra (free bromine vs bromine clathrate hydrate) clearly demonstrated the dramatic change that bromine undergoes after enclathration. The observations made in this project can be extended to other guest molecules such as methane or natural gas when developing methods for optimal storage and transportation in a form of solid clathrate hydrate for oil/energy industry.	
<b>Summary Statement</b> I produced bromine clathrate hydrates from deuterated water, and studied the hydrates' guest-host interactions.	
<b>Help Received</b> Dr. John Kenney at Concordia University helped me set up my spectroscopy tests.	