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Synthetic and Bioorganic Chemistry and Organic Spectroscopy

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B.S., 1988,
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Selected Publications

Mimicking Microbial Rhodopsin Isomerization in a Single Crystal, Ghanbarpour, A.; Nairat, M.; Nosrati, M.; Santos, E. M.; Vasileiou, C.; Dantus, M.; Borhan, B.; Geiger, J. H., *J. Am. Chem. Soc.* **2019**, *141(4)*, 1735-1741.

Cu-Catalyzed Oxidation of C2 and C3 Alkyl-Substituted Indole via Acyl Nitroso Reagents, Zhang, J.; Torabi Kohlbouni, S.; Borhan, B., *Org. Lett.* **2019**, *21(1)*, 14-17.

A Near-Infrared Photoswitchable Protein-Fluorophore Tag for No-Wash Live Cell Imaging, Sheng, W.; Nick, S. T.; Santos, E. M.; Ding, X.; Zhang, J.; Vasileiou, C.; Geiger, J. H.; Borhan, B., *Angew. Chem. Int. Ed. Engl.* **2018**, *57*, 14742-14746.

Absolute and relative facial selectivities in organocatalytic asymmetric chlorocyclization reactions, Marzijarani Salehi, N.; Yousefi, R.; Jaganathan, A.; Ashtekar, K. D.; Jackson, J. E.; Borhan, B., *Chem. Sci.* **2018**, *9*, 2898-2908.

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Absolute Stereochemical Determination of Asymmetric Sulfoxides via Central to Axial Induction of Chirality, Gholami, H.; Zhang, J.; Anyika, M.; Borhan, B., *Org. Let.* **2017**, *19*, 1722-1725.

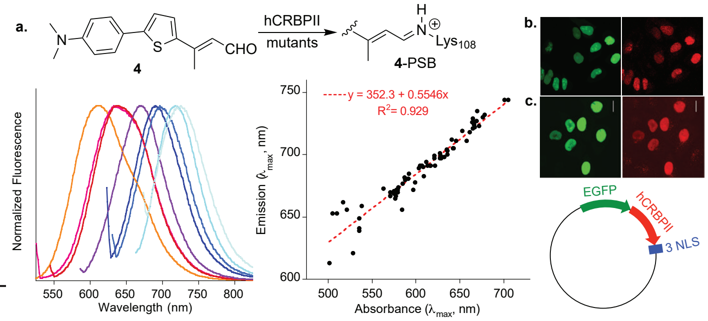
Nucleophile-Assisted Alkene Activation: Olefins Alone are Often Incompetent, Ashtekar, K.D.; Vetticatt, M.; Yousefi, R.; Jackson, J. E.; Borhan, B., *J. Am. Chem. Soc.* **2016**, *138(26)*, 8114-8119.

Sensing Remote Chirality: Stereochemical Determination of beta-, gamma-, and delta-Chiral Carboxylic Acids, Tanasova, M.; Anyika, M.; Borhan, B., *Angew. Chem. Int. Ed. Engl.* **2015**, *54*, 4274-4278.

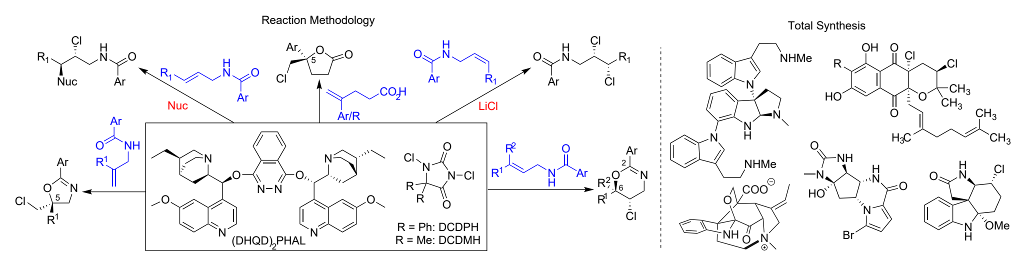
Tuning the Electronic Absorption of Protein-Embedded All-trans-Retinal, Wang, W.; Nossoni, Z.; Berbasova, T.; Watson, C. T.; Yapici, I.; Lee, K. S. S.; Vasileiou, C.; Geiger, J. H.; Borhan, B., *Science* **2012**, *338*, 1340-1343.

The research interests of our lab can be subdivided into the three main areas of ***Bioorganic Chemistry***, ***Synthetic Chemistry***, and ***Organic Spectroscopy***.

Our ***Bioorganic Chemistry*** efforts are geared towards elucidation of the interaction of bioactive compounds with receptors and proteins. We rely heavily on de novo protein design and mimicry of natural systems to better understand how certain biological processes occur. As an example, we have initiated research into designing protein mimics of rhodopsin, the protein responsible for vision, which can bind retinal as a protonated Schiff base [PSB] (same binding mode as in rhodopsin). These protein mimics are used to investigate the wavelength regulation mechanism that enables color vision. Currently we are using our engineered proteins as colorimetric and fluorescent proteins for cellular tagging and intracellular pH sensors.



Our ***Synthetic Chemistry*** program is generally focused on the development of new reactions that utilize simple organic molecules and through designed manipulations lead to more complex systems. In most cases, our methodologies lead to the production of heterocycles with regio- and stereo-control. These transformations are then highlighted in total syntheses of natural products that exhibit interesting biological activities. Our most recent efforts have focused on developing new catalytic asymmetric olefin halofunctionalization chemistry. These reactions are often catalyzed by $(DHQD)_2PHAL$ in combination with various N-chlorinated hydantoins as the terminal chlorenium sources. Halofunctionalization of different compounds, along with understanding the mechanism of these transformations via NMR, REACT-IR, studies of kinetic isotope effect, and computational analyses are currently under investigation.



In the area of ***Organic Spectroscopy***, we are interested in developing host/guest systems that can be used in the absolute stereochemical determination of chiral compounds. We accomplish this through the design and synthesis of chromophoric receptors, which upon binding with the chiral compound function as reporters of chirality. We rely heavily on Circular Dichroism (CD) as the tool for observing the host/guest interactions between the chiral compounds and the receptors. In particular, we will take advantage of the excitonic coupling between independently conjugated chromophores that make up the receptors to establish non-empirical guidelines for the absolute stereochemical determination of asymmetric centers.