



Synthesis and Characterization of an Asymmetric Rotor

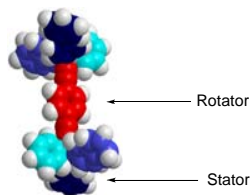
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Abstract:

The construction of machines on the molecular scale is an emerging field in nanotechnology, however, the translation from macroscopic to microscopic is not as facile as one would hope. Macroscopic machine designs rely on parts that obey Newtonian, inertial motion, while single molecules undergo quantum mechanical, quantized motion. As such, we have been working with the synthesis of crystalline molecules that can act as parts of a machine with both moving and non-moving parts—called amphidynamic crystals. Furthermore, these crystals are designed such that their motion can be controlled. The specific molecules that we aim to synthesize are called rotors and are modeled after macroscopic gyroscopes. The specific rotor we are synthesizing consists of a stator connected through a chiral carbon to an aromatic rotor, which can spin freely on its axis. Hopefully, the chirality of the carbon will install a unique environment at any point during a single rotation of the rotor. The slope of barrier to rotation, therefore, should be smaller in one direction relative to that of the other. The resulting asymmetric potential can be interfaced with a periodic perturbation that may result in unidirectional motion, as expected for a Brownian ratchet. Once the rotor has been synthesized, the barrier of rotation of the rotor, and speed of the rotation, will be determined by solid-state NMR spectroscopy.

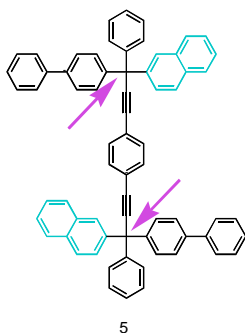
Amphidynamic Crystals:



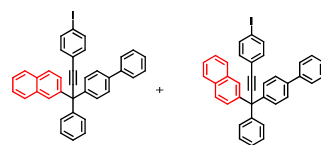
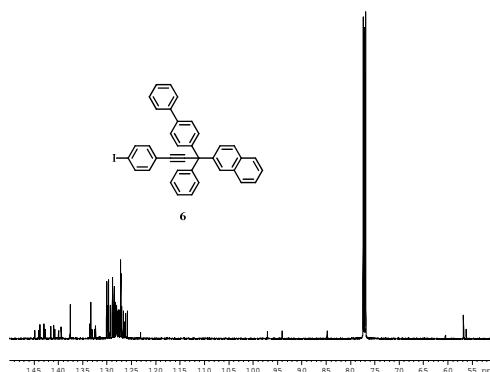
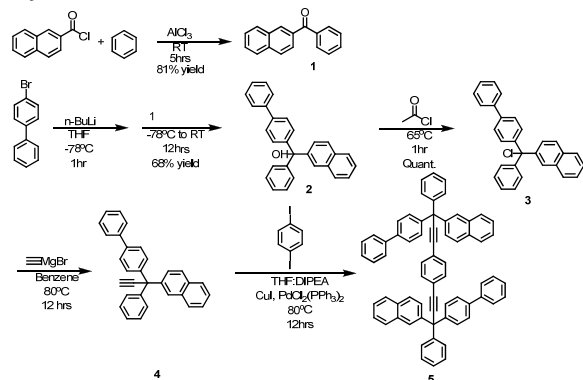
The rotor is made up of the stator, which remains stationary and the rotor, which can spin on its axis

Chirality:

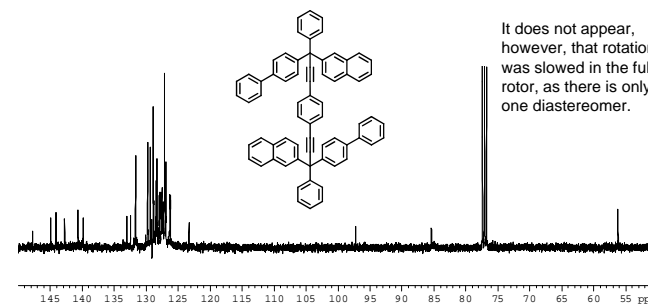
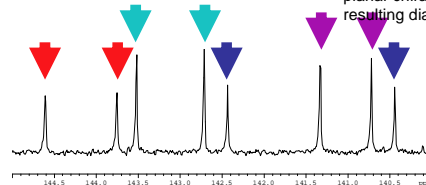
Three different chiralities
Stereocenters (2)
Planar Chirality (2)
Helical Chirality (2)
 $2^6=64$ different possible stereoisomers



Synthesis Scheme:



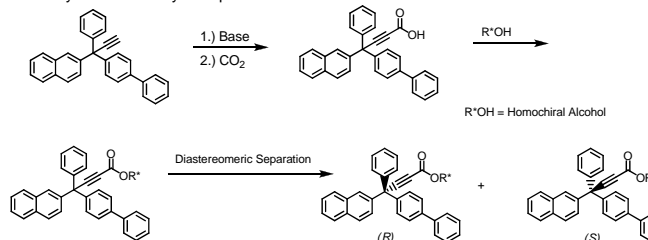
Note in the NMR below that the peaks come in pairs consistent with diastereomers. Steric bulk slows the rotation about the bond connecting the naphthalene group creating planar chirality and the resulting diastereomers.



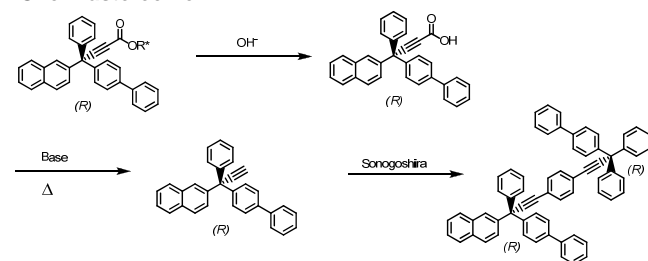
It does not appear, however, that rotation was slowed in the full rotor, as there is only one diastereomer.

Future Work:

Synthesis leaves racemic stereochemistry, but to study the effects of chirality it is necessary to separate the enantiomers



One Diastereomer:



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