Controlled Chaos: Hydrogen Bonds Made to Enforce Molecular Disorder

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Abstract:

Molecular structure impacts the properties of materials both directly and indirectly, by influencing how individual molecules interact in the bulk. To this end, non-covalent interactions such as hydrogen bonds have been abundantly used to generate self-assembled structures with order on the nanoscale. However, is it possible to use such interactions to prevent the formation of ordered structures and instead obtain amorphous materials, however counterintuitive it may seem?

Amorphous materials are ubiquitous in everyday life, ranging from glass to polymers, foods, and optoelectronic devices. While most amorphous materials are constituted of polymeric structures, small molecules capable of forming amorphous phases (molecular glasses) possess notable advantages, being easy to purify, characterize and process, but at the same time often suffering from limited accessibility to the amorphous state and the propensity to crystallize over time.

Strategies developed in our group to use hydrogen bonds to frustrate crystallization rather than promote it will be discussed, along with the role played by molecular structure and hydrogen bonding in influencing the properties of these materials, and perspectives to utilize these strategies to design functional glasses.