Chemical Reactions under Vibrational Strong Coupling

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Inside an optical cavity, cavity fields can exchange energy with the vibrational transitions of molecules. When conditions allow this energy exchange to occur repeatedly, i.e. vibrational strong coupling (VSC), the molecular and photonic wavefunctions are hybridized. Most recently, it was discovered that the chemical reactivity of molecules in optical cavities is changed because of the reshaped Morse potential under VSC. The exploration of VSC chemistry has only just begun and the field awaits comprehensive development in molecular chemistry.

We demonstrate that VSC of the aldehyde/ketone carbonyl stretching can control the rate of cyclization reactions. In another application of VSC, we investigate the influence of VSC of solvent molecules on metal-organic frameworks (MOFs) crystallization. We show that VSC of the solvent (water) can indeed influence the formation of MOF structures. These results indicate the versatility of VSC as a tool to modulate chemical reactions, opening a new cross-disciplinary domain between quantum photonics and molecular chemistry.