SUMMARY

Considering sustainability as the primary objective, synthetic chemists are encouraged to utilize renewable energy sources and green strategies for molecular transformations. Photocatalysis is among the media that allow scientists to achieve real-applicable molecules *via* chemical reactions with minimal carbon footprints. However, it is potentially constrained by issues with catalyst efficiency and light spectrum limitations. Addressing these issues, mobilizing multi-photon absorption-driven photocatalysis can provide a game-changing podium. Including these in our manifesto, this thesis presents a paradigm-shifting discovery in synthetic chemistry, addressing growing concerns over financial and environmental sustainability in photocatalysis. We have showcased the activation of the C-Br bond of $CBrX_3$ (X = Br, Cl) using Mes-Acr-$MeClO_4$ homogeneous photocatalysis for synthesizing *gem*-dihaloenones. In the search for low-energy visible light photocatalysis, green light-driven synthesis of *N*-vinyl acetamide was achieved *via* a green light-absorbing charge-transfer complex formed between Mes-Acr-$MeClO_4$ and *N*-bromoacetamide in the presence of K_2CO_3. In addition, perylene diimide radical anion was established as a three-photon absorbing blue LED photocatalyst at ppm concentration in a three-component addition reaction to yield (*E*)-enenitriles. Then, we also developed orthorhombic $CsPbBr_3$ perovskite NCs as heterogeneous visible light photocatalysts and utilized it for synthesizing *gem*-dihaloenones and vinyl sulfinylsulfonyls, independently from terminal aromatic alkynes. Following this, we explored anhydrous-$CeCl_3$ as a semi-heterogeneous photocatalyst, forming a charge-transfer complex with NXS (X = Br, Cl) in moist acetonitrile, generated halogen radicals, which reacted with phenylacetylenes under blue LED to yield dihaloketones. Besides photocatalysis, we reported the origin of 100% *Z*-selectivity for the synthesis of (*Z*)-styryl sulfides *via* lithium *tert*-butoxide-promoted C-S bond formations from phenylacetylenes and benzyl mercaptans in EtOH under ambient reaction conditions.