LASER SPECTROSCOPY OF AROMATIC MOLECULES WITH OPTICAL CYCLING CENTERS: STRONTIUM (I) PHENOXIDES

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Optical cycling, a phenomenon in which atoms or molecules rapidly emit photons after optical excitation in a repeated cycle, is important in laser cooling and trapping, as well as state preparation and measurement. Theoretical and experimental works [1, 2, 3] show that aromatic compounds functionalized with an M-O unit for optical cycling (M = Ca or Sr) can be made suitable for repeated photon scattering. Here, we report the production and spectroscopic characterization of strontium (I) phenoxide (SrOC6H5, or SrOPh) and variants featuring electron-withdrawing groups designed to suppress vibrational excitation during spontaneous emission from the electronically excited state. By using dispersed laser-induced fluorescence spectroscopy, we discovered that the cycling closure of these species, which is the decoupling of vibrational state changes from spontaneous optical decay, is high, which is consistent with theoretical predictions. A high-resolution, rotationally resolved laser excitation spectrum is also recorded for SrOPh, allowing the estimation of spectroscopic constants and identification of candidate optical cycling transitions for future work. The results show the promise of strontium phenoxides for laser cooling and quantum state detection at the single-molecule level. This work also suggests that a larger class of molecules than previously realized may be amenable to laser cooling.

(1) Dickerson, C. E.; et al. Phys. Rev. Lett. 2021, 126, 123002. (2) Dickerson, C. E.; et al. J. Phys. Chem. Lett. 2021, 12, 3989–3995. (3) Zhu, G. Z.; et al. Nat. Chem. 2022, 14, 995–999.