Diarylethene-based photochromic probes for reversible switchable vibrational imaging

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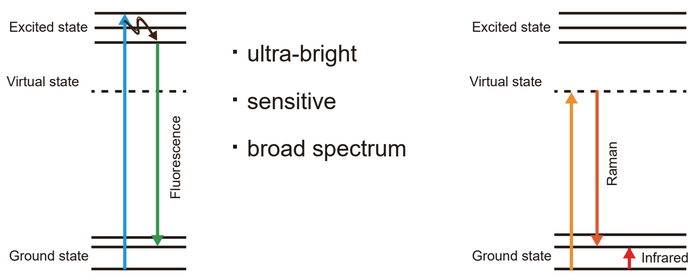
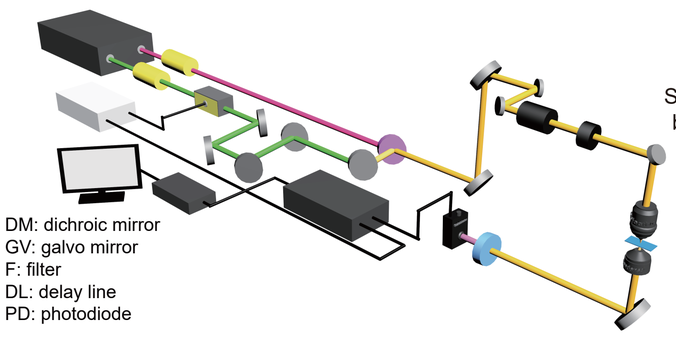
Introduction

Fluorescence microccopy V.S. Vibrational microscopy



- ultra-bright
- sensitive
- broad spectrum

- superior chemical specificity
- label-free
- small cross section (Raman) low spatial resolution (IR)



Stimulated Raman scattering (SRS) microscopy, boosted conventionally weak Raman scattering by coherent and nonlinear optical process (~10^3-10^5 gain), enabling rapid label-free chemical imaging for living cells and tissues.

However, insufficient sensitivity and chemical specificity have hindered conventional SRS microscopy for studies in molecular and cell biology.
In this work, we engineered alkyne tagged diarylethene to realize photo-switchable stimulated Raman scattering probes with high chemical resolution, for applications in living cells

Results & Discussion

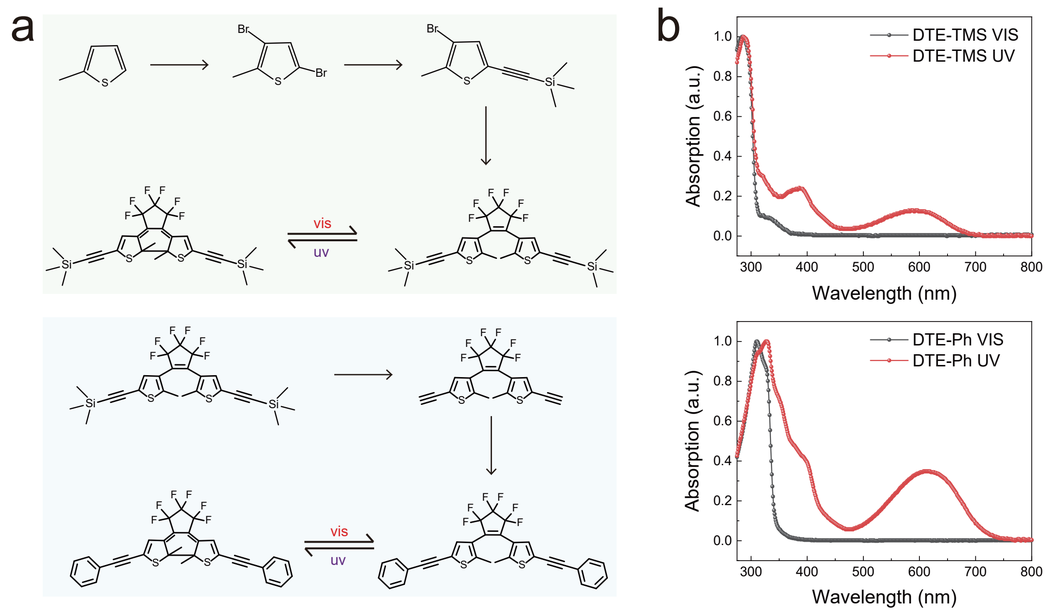


Fig.1 Photo-switching properties of DTE-TMS and DTE-Ph. (a) The synthesis route of DTE-TMS and DTE-Ph; (b) Absorption spectra of DTE-TMS and DTE-Ph after visible or UV irradiation.

When photoisomerization occurs under UV irradiation, the ring-closing reaction changes the electronic structure and redshifts the absorption spectra of the DTE unit.

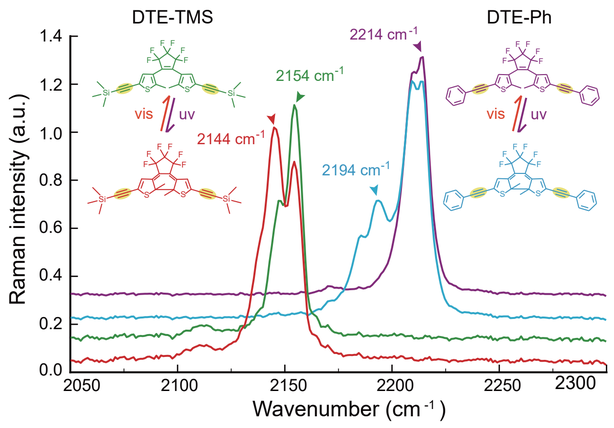


Fig.2 Spontaneous Raman response of the photoisomerization process of the DTE-alkyne derivatives

UV (360 nm) induced photo-cyclization converts the open-ring isomers (green and purple) to the closed-ring structures (red and blue), resulting in spectra red-shifts of the alkyne spontaneous Raman peak.

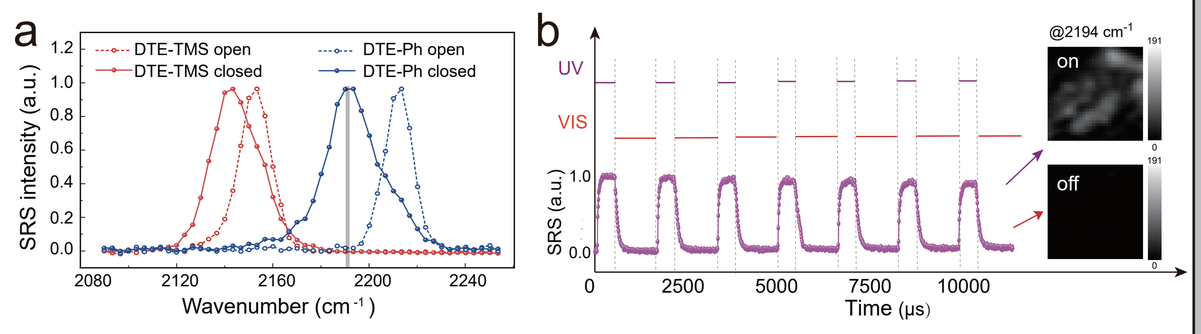


Fig.3 Stimulated Raman response of the photoisomerization process of the DTE-alkyne derivatives. (a) SRS spectra of DTE-TMS and DTE-Ph in the open- and closed-ring forms. (b) SRS signal of DTE-Ph acquired at the UV-induced Raman frequency (2194 cm-1) shows on/off switching behavior under UV/visible pulsed irradiations.

Consequently, a stronger redshifted and quasi-single peak SRS lineshape could be reversibly generated/eliminated by UV/visible irradiation.

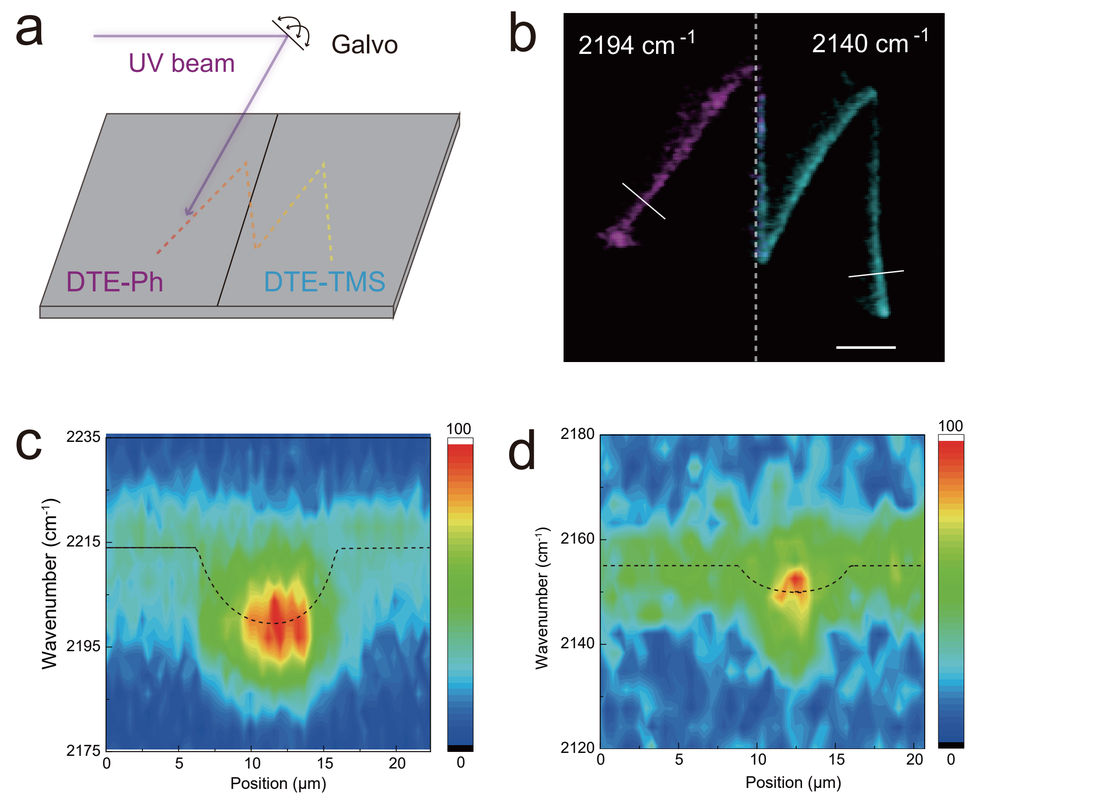


Fig.4 Photo-switchable SRS patterning. (a) UV beam written letter “M” across the border of DTE-Ph and DTE-TMS coated areas allows dual-color SRS imaging of the two sub-portions of the letter (b) with varying SRS spectra along the line-cuts in the DTE-Ph (c) and DTE-TMS (d) regions. Scale bars: 20 μm.

Rewritable pattering with SRS microscopy could thus be accomplished by scanning UV focal spot in specific areas with programmed patterns, as well as erasing them with visible irradiation.

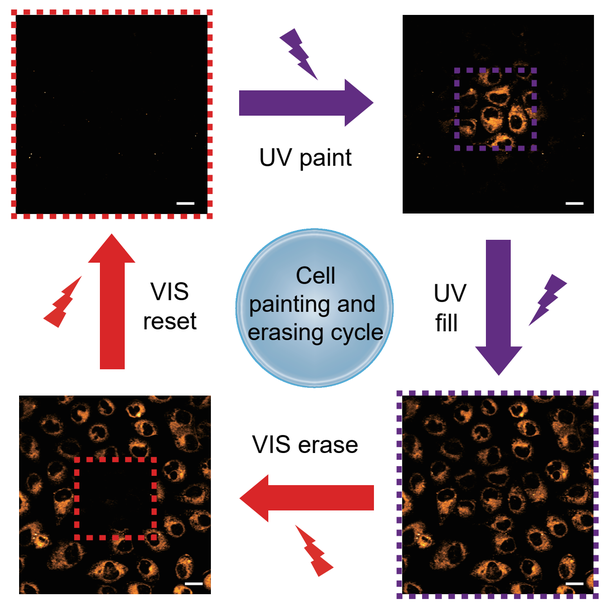


Fig.5 Live cell painting and erasing with SRS microscopy.

The cycling results verified these molecules could serve as photo-active switchable SRS probes for live cell imaging, and may hold potentials for cell painting and sorting.

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Conclusion

We have demonstrated photo-switchable SRS microscopy with alkyne-tagged photochromic probes for information pattering and live cell imaging. Our work holds promise for super-resolution SRS imaging, 3D optical memory/switch and frequency multiplexed storage with vibrational contrasts.

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