

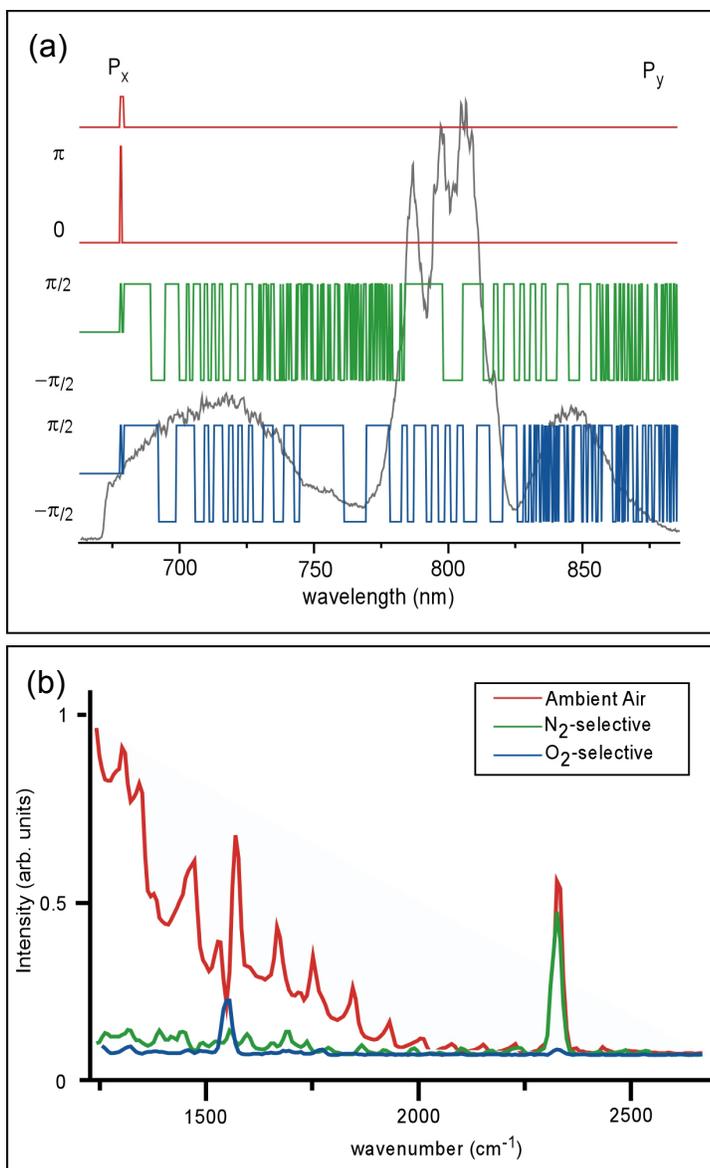
## MIIPS<sup>®</sup> Application Notes

### Single-Beam CARS Spectroscopy of Gas Phase Molecules

One of the most interesting developments in coherent anti-Stokes Raman scattering (CARS) spectroscopy has been the introduction of single-beam CARS microscopy by Prof. Silberberg's group [1]. It utilizes a single broadband laser pulse to both excite and probe coherent vibrations of Raman-active molecules. Polarization and phase shaping have been demonstrated to reduce the non-resonant background from the single-beam CARS experiments [2]. Binary phase shaping (BPS) not only further suppress the non-resonant background but also selectively excite a particular Raman mode [3]. Here the applications of BPS on gas mixtures are demonstrated.

Figure 1(a) illustrates the polarization and phase profile (red) along with output broadband spectrum (grey). The first of the two binary phases (green) provides selective excitation of  $2330\text{ cm}^{-1}$  mode of nitrogen molecule. The other binary phase (blue) ensures selective excitation of  $1555\text{ cm}^{-1}$  mode of oxygen molecules. Multiphoton intrapulse interference phase scan (MIIPS<sup>®</sup>) has been used to deliver a transform-limited phase for the ultra-broad bandwidth spectrum to ensure the accurate delivery of the binary phases [4].

Figure 1(b) illustrates the effect of BPS compared to that of original single-beam CARS phase-polarization shaping. BPS selectively isolates excited vibrational modes from two separate species (oxygen and nitrogen) with minimal loss of resonant signal intensity. Furthermore, the decrease in overall non-resonant contribution allows for retrieval of Raman-resonant signal that could be potentially lost because of the large non-resonant background.



**Fig. 1.** (a) Polarization and phase profiles used in the standard and mode-selective single-beam CARS experiments; two binary phases for selective excitation for different vibrational modes; (b) Selective excitation of  $\text{N}_2$  and  $\text{O}_2$  vibrational modes in ambient air. CARS spectra of air in the original single-beam CARS scheme (red) and mode-selective BPS for  $\text{N}_2$  and  $\text{O}_2$ . The figure is adapted from ref. [3]

#### References

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- [2] D. Oron, N. Dudovich, and Y. Silberberg, *Phys. Rev. Lett.* **90**, 213902 (2003).
- [3] H. Li, D. A. Harris, B. Xu, P. J. Wrzesinski, V. V. Lozovoy, and M. Dantus, *Optics Express* **16**, 5499 (2008).
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