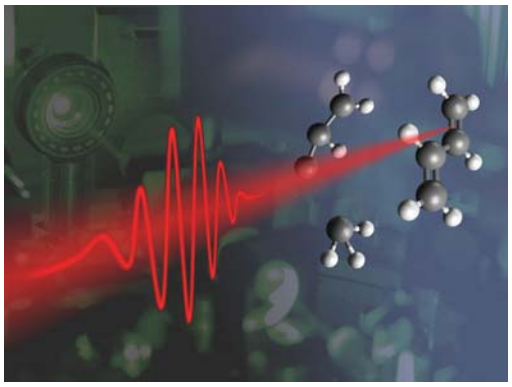
Single Beam Femtosecond Multiplex CARS

S&T Campaign: Materials Research
Photonics

Dr. Paul Pellegrino, (301) 394-2030
paul.m.pellegrino.civ@mail.mil

Research Objective

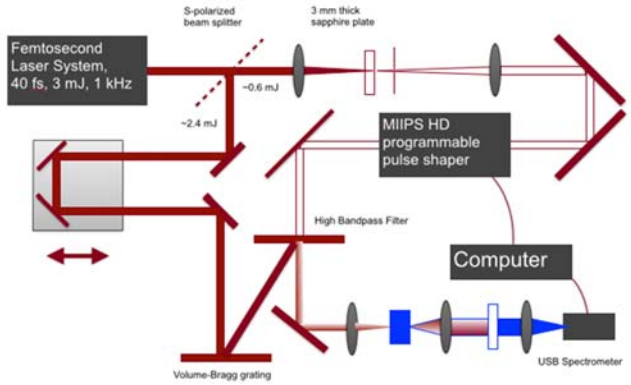
- Develop an optical sensor using multiplex coherent anti Stokes Raman spectroscopy (MCARS) that can rapidly identify a wide variety of molecules at trace concentration levels and standoff distances.
- Build a scientific foundation for completely new optical and spectroscopic chemical detection schemes using ultra-short pulsed laser (USPL) light as a tailorable photonic reagent.



An ultra short IR laser pulse breaking an organic molecule.
Credit: TU Wien

Challenges

- The drive toward complete Soldier protection from hazardous materials may require completely new optical strategies to achieve the requisite sensitivity for surface contamination.
- Current state of the art systems for chemical detection/identification lack adaptability and discrimination capability.
- Differing detection environments demand versatile and robust detection scheme.



MCARS experimental setup

ARL Facilities and Capabilities Available to Support Collaborative Research

- Experimental spectroscopy laboratory facilities of over 1000 sq. ft. containing USPL sources (Coherent Legend Elite USP and PolarOnyx Fiber Laser), characterization equipment (FROG, Grenouille, MIIPS), and standard sources covering UV-IR (Altos OPA 200 nm – 15 µm & tunable QCL sources 9 – 11 µm).
- Unique ARL expertise: We have capability to produce and control USPL research to investigate numerous excitation schemes for detection purposes including MCARS, filamentation, and coherent control via pulse-shaping. We are one of the first groups to analytically remove non-resonant background from MCARS signals using an analytic two step approach.
- Significant early findings: We are able to generate complete Raman spectra in milliseconds using MCARS.
- References:
  - S. D. Roberson, P. M. Pellegrino, Removal of non-resonant background in MCARS spectra using Fourier filtering, Proc. SPIE (2015).
  - S. D. Roberson, S. Bowman, P. M. Pellegrino, A study of single-beam femtosecond MCARS in trace material detection, Proc. SPIE (2015).
  - J. J. Brady, M. E. Farrell, and P. M. Pellegrino, Optical Engineering 53, 2 (2013).

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Current program lacks vigorous theoretical and modeling support for phenomena being pursued.
- Current program has not extended itself to femto-chemistry or higher harmonic studies of light matter interactions.
- Interest in new innovative USPL detection schemes and lines of research including pulse-shaping and tailored excitation.
- Interest in new and robust USPL sources are sought to create robust methods for Army use in relevant environments.