Multi-Photon Counting in Raman Spectroscopy By Signal Processing of Photomultiplier Tube Response

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- Chemistry and Chemical Analysis
- Computer Technology

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- Analytical Chemistry
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- Electrical Engineering
- Multiphysics
- Optical Sensing
- Photonic
- Photonic Interface
- Photons
- Raman Spectrometry
- Research Tool
- Software

Researchers at Purdue University have developed a new method to enable multi-photon counting in Raman spectroscopy through sub-nanosecond digital signal processing of photomultiplier tube (PMT) responses to laser pulses. The hardware and software system can be implemented in research and industry applications for nondestructive chemical and physical analysis. The setup allows for rapid analysis of a variety of chemical samples over a broad range of low and high concentrations, with enhanced speed and sensitivity relative to traditional Raman techniques. In addition, this approach can decrease total experiment times and improve noise rejection. Currently photon counting techniques consider photon arrivals as binary events that are assessed by a single threshold. Purdue researchers have focused on the potential to strengthen signals via high-speed data acquisition and multi- threshold digital signal processing (DSP) of detector response to multiple coincident or nearly coincident photon arrivals. Their software features an algorithm for multi-photon counting and hardware to record PMT output, considering amplitude and time characteristics of detector response. In testing of aqueous solutions of nitrate, isopropanol, and rhodamine 6G, sensitivity was increased by 2.0-, 2.0-, and 3.1-fold respectively relative to traditional Raman spectroscopy analysis. Calibration curves showed decreased susceptibility to saturation, as well.

Advantages:
-Multi-Photon Counting
-Stronger Signal
-Allows for Broader Low/High Concentration Range for Sample Analysis
-Decreases Experimentation Time
-Improves Noise Rejection
-Increases Spectroscopic Sensitivity on Average 2- to 3-Fold

Potential Applications:
-Raman Spectroscopy
-Wireless Sensing Systems
-Research Analysis and Sampling

Technology Validation: In three unique aqueous solutions, the sensitivity of the new system developed by Purdue researchers was compared to current Raman spectroscopy systems. An increase by 2- to 3-fold in sensitivity was achieved for each, and saturation thresholds were extended to broaden useful sensor range.

People:

- Sinfield, Joseph V (Project leader)
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Intellectual Property:

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