USE OF A PORTABLE, HANDHELD DEVICE FOR THE DETECTION OF PYRETHROIDS

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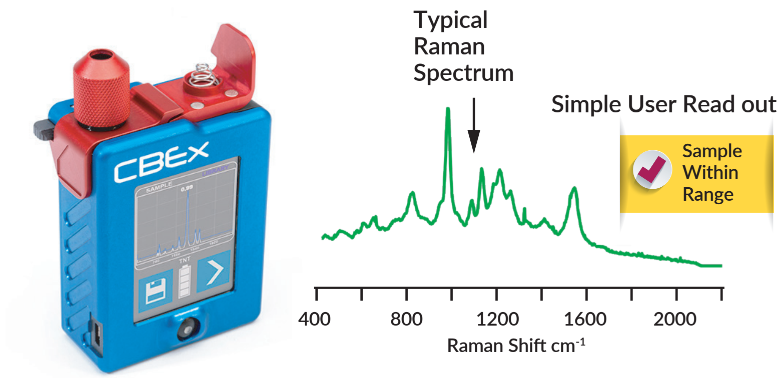
INTRODUCTION

Agriculture markets use more than 400,000 pounds of Permethrin across over 3 million acres in the United States. Pistachios, lettuce, corn, and potatoes account for the highest agricultural usage (in pounds) of permethrin. Approximately half of all agricultural usage of permethrin occurs in California. The majority of non-agricultural usage is by consumers for outdoor use. Consumers use approximately 1.75 million pounds of permethrin for outdoor use. Pest control operators use approximately 450,000 pounds and an additional 100,000 pounds is used for mosquito abatement.

The California Stormwater Quality Authority (CSQA) July 2013 report assessed the effects of extensive pyrethorid use within the state and the implications this is having on stormwater and sediment. A key recommendation of CSQA report is for industry and regulatory groups to establish a systematic means of analytical protocols sufficient to detect pesticides at environmentally-relevant concentrations in both waters and sediments.

HANDHELD DETECTION METHODS

The industry currently relies on GC-MS for the accurate detection of low levels of pyrethroids. These methods are costly, time consuming and complexities are such that GC-MS methods are not likely to be suitable for translation to field use conditions. iFyber has demonstrated the use of portable Raman spectroscopy and selective assay chemistry for purposes of detecting trace levels of pyrethroids in solid and aqueous materials. Raman instrumentation today has the form factor of a handheld mobile communication device, capable of running on low power (e.g., AA batteries). Combined with the technique of surface-enhanced Raman scattering (SERS), iFyber has developed a number of assays for the detection of pyrethroids at trace levels (ppb).



Raman Instrumentation & Selective Chemistry for Permethrin Detection

APPLICATION NOTE: PERMETHRIN LOADINGS IN MILITARY FABRICS

iFyber has gathered preliminary data to generally assess the feasibility of detecting permethrin content in military fabrics using Raman/SERS and selective assay chemistry. Two preliminary assays have been developed: a destructive assay that provides quantitative results down to ppb levels, and a non-destructive, spot assay that provides positive identification with rough order of magnitude prediction of permethrin content.

RESULTS

Method Calibration. As with any new analytical detection method, a calibration data set was developed in order to determine a limit of detection (LOD) and a limit of quantitation (LOQ). As shown in Figure 1, in combination with iFyber's SER-PA™ assay chemistry, the presence of permethrin produces a unique Raman spectral fingerprint with an intensity that varies as a function of the permethrin content. From these data, a LOD of 20 nM and a LOQ of 65 nM was calculated for permethrin in solution.

APPLICATION NOTE: USE OF A PORTABLE, HANDHELD DEVICE FOR THE DETECTION OF PYRETHROIDS

PRELIMINARY SER-PA™ ASSAY ON FABRICS

Using the calibration data shown in Figure 1, iFyber has obtained preliminary assay results that suggest our method can be used to rapidly quantify permethrin content on fabrics. As expected, analysis of permethrin extracts from standard military garments (Insect Shield) using iFyber's SER-PA™ assay chemistry leads to a unique Raman signature that is easily distinguishable from control fabrics (Figure 2). Using a destructive assay, fabric swatches can be extracted with an appropriate solvent, combined with SER-PA™ assay chemistry, to give spectral data that can be compared to the calibration data for permethrin quantitation. Importantly, tracking the fate of permethrin over the course of a fabric's lifetime should be possible given the sensitivity of the iFyber SER-PA™ assay.

iFyber has further demonstrated the ability to detect permethrin by spot testing a specific location of an intact fabric sample. Assay results from this non-destructive test agree well with the destructive assay as indicated by the similar spectral fingerprints presented in Figure 3. The assay can be completed in less than two minutes to provide a reliable qualitative result for permethrin content. This method can be used to assess the coating process during garment finishing, or to provide a rapid rough order of magnitude estimate of permethrin content (e.g., within 20%) at any point in the lifetime of a garment.

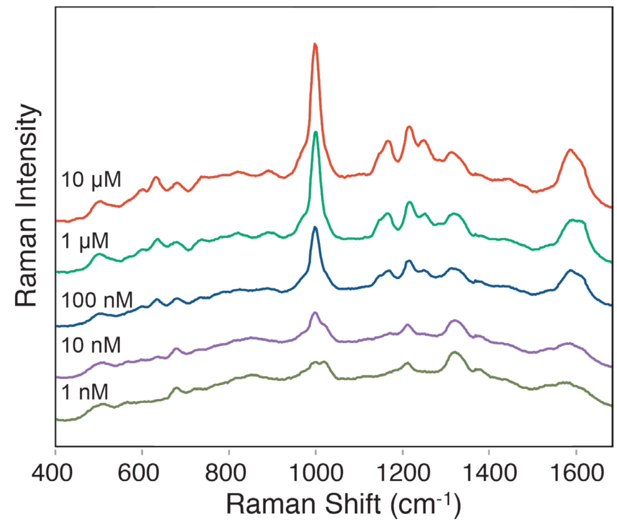


Figure 1. Calibration Data. Representative Raman spectra of solutions containing permethrin at various concentrations in the presence of iFyber SER-PA™ assay reagents.

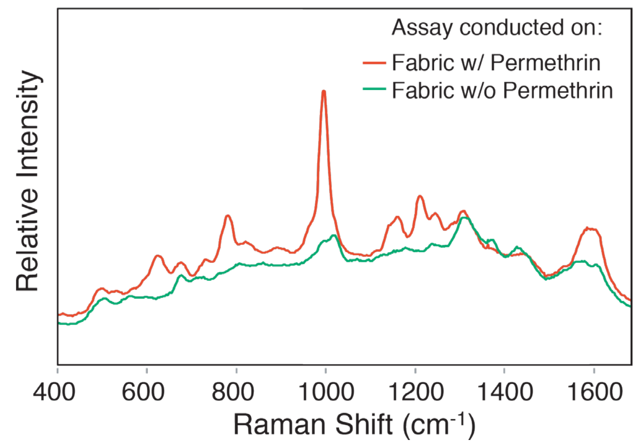


Figure 2. Assay Results. Representative Raman spectra resulting from assaying fabrics for permethrin content. Two fabrics from Insect Shield were tested: standard issue permethrin loaded fabric and a control fabric having no permethrin.

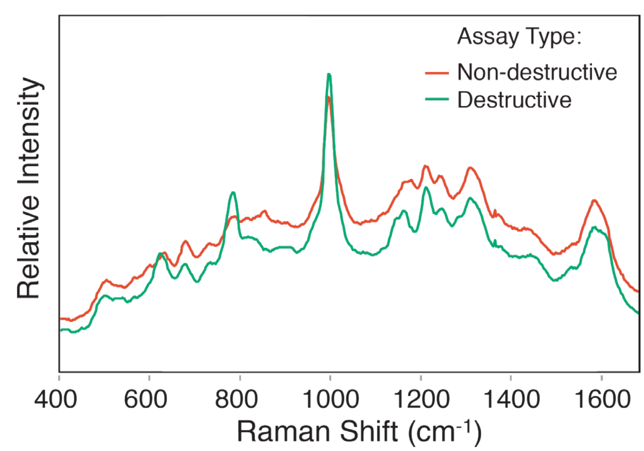


Figure 3. Assay Comparison. Tests results from two assay types (i.e., destructive vs. non-destructive) exhibit good correlation in permethrin content.

CONCLUSION

iFyber has demonstrated feasibility for testing pyrethroids (i.e.,. permethrin) at nanogram levels through the use of portable,handheld Raman instrumentation and selective SERS-based assay chemistries. With form factors that are handheld, and with simplified assay methods utilizing cost effective assay kits, there are opportunities to establish new protocols for the effective monitoring of pyrethroids effecting textile, food, water, and environmental markets.