SNL-NM Traditional and Emerging Capabilities for Bioscience Research

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1. Introduction

Sandia's **Materials Characterization Department 1822** employs a variety of tools for bioscience research for both internal and external customers. The variety of equipment and expertise accessible internally enables cutting-edge analytical measurements. Additional methods and instrumentation not discussed here are also available, from gas measurements to unknown determination to collaborative research and development.

2. Traditional separations, multiple detection platforms.

We use "traditional" chromatography tools with various detectors to balance customer's needs and budget. Figure 1 shows quantitative analysis of a biodiesel sample (A) and reference standard (B) using gas chromatography flame ionization detection (GC/FID) for rapid quantitation of target triglycerides and glycerine. For more complex samples or for unknown identification, GC with mass spectrometry (MS) detection is available. **BENEFITS:** Quantitative analysis, unknown identification.

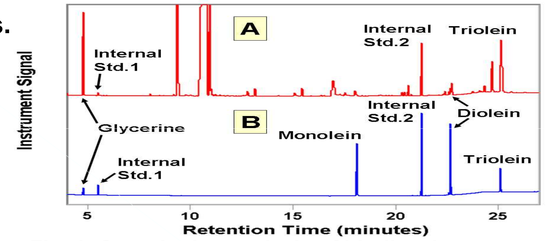
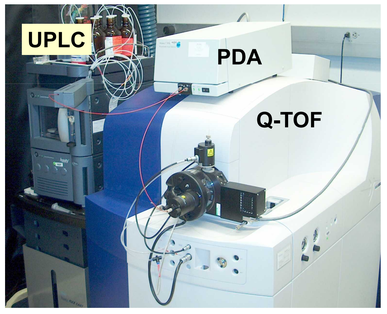


Fig. 1. Quantitative analysis of biodiesel components.

3. High performance Liquid Chromatography LC-MS/MS

When the research calls for resolution, separation performance, or tandem MS capabilities beyond standard LC/MS, we employ UPLC/MS/MS as shown in fig. 2. Applications include identification and strutural analysis of complex mixtures and unknowns, metabolomics, expression analysis, proteomics, sequencing, polymers. **BENEFITS:** high mass resolution, high separation performance, structural determination.



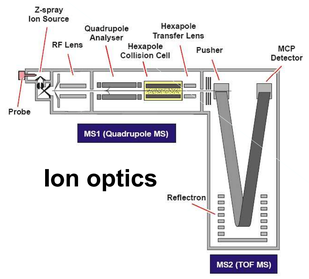


Figure 2: High performance UPLC with Photodiode Array (PDA) Detector and Q-TOF mass spectrometer.

The figure below illustrates a peptide mixture separation. The experiment provides 4 dimensions of information for each peptide – (1)-abundance, (2)-retention time, (3)-mass spectrum (mass to charge or m/z) and (4)-optical absorbance (not shown). For sequencing or structural information an additional step - (5) MS/MS fragmentation and analysis is used. **BENEFITS:** high confidence multi-dimensional measurements, peptide sequencing, unknown identification.

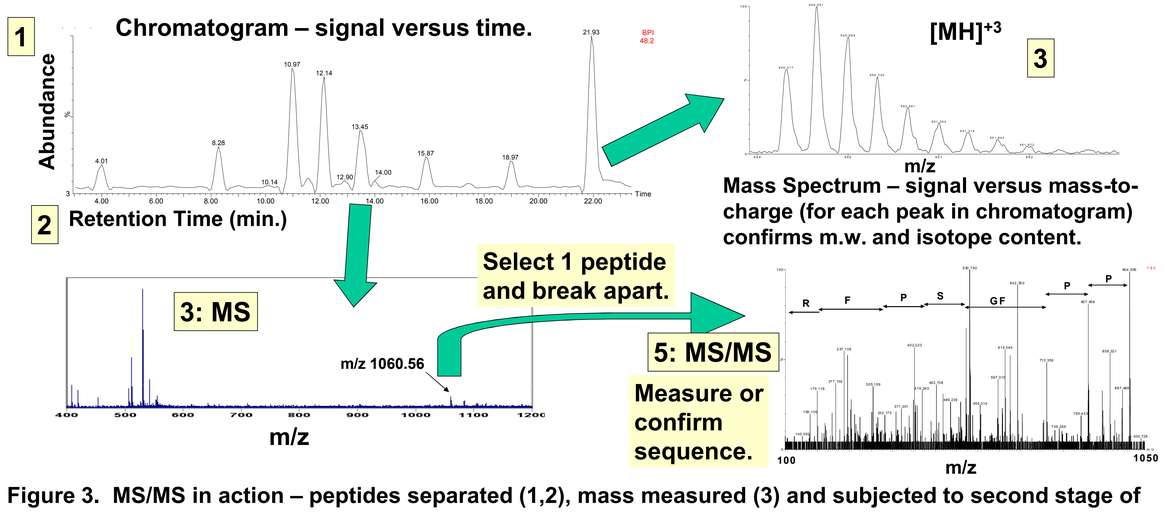


Figure 3. MS/MS in action – peptides separated (1,2), mass measured (3) and subjected to second stage of fragmentation and measurement generating MS/MS spectrum (5), which confirms sequence as RFPSGFPP. Sequence can then be submitted to database search.

3. Emerging Capabilities – thermal techniques coupled to large molecule analysis – polymers and peptides.

A new technique has been demonstrated in which peptide and polymer samples can be thermally treated and/or their thermal properties investigated using a microfabricated hotplate[1,2]. Following these tests the sample can be interrogated directly using MALDI-MS (matrix-assisted laser desorption ionization) or DESI-MS (desorption electrospray ionization) to measure intact high-molecular weight products[3,4]. **BENEFITS**: direct molecular analysis, high-mass (>1000 dalton), precise thermal control, calorimetric measurements.

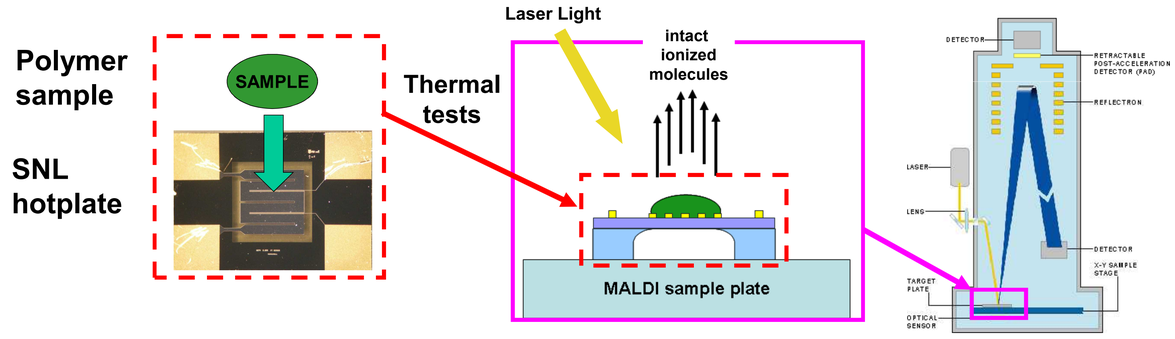


Figure 4. Schematic of thermal probe / MALDI-MS experiment. Sample is deposited, thermal testing or analysis is performed, matrix added and hotplate placed into mass spectrometer for analysis.

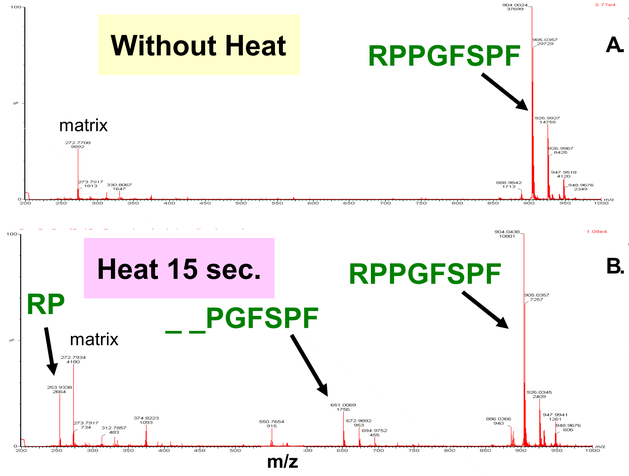


Figure 5. MALDI-MS analysis of a thermal "digestion" (enzyme-free) of peptide RPPGFSPF. Without heat (top) the intact peptide is measured (along with M+Na and M+K) whereas after 15 seconds of heating (bottom) the peptide is digested – both complimentary fragments are observed.

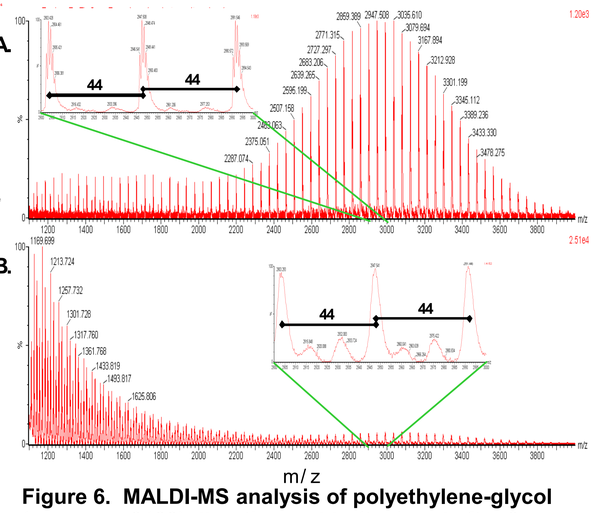


Figure 6. MALDI-MS analysis of polyethylene-glycol (avg. m.w. 3400) directly on-chip (top) and after 2 cycles of calorimetry measurements up to 130°C (bottom). A dramatic shift to lower molecular weight and additional chain fragments are observed after heating.

6. Conclusions

Traditional analytical capabilities are enabling quantitative, qualitative, molecular weight, elemental, and isotopic measurements of organic and inorganic species including polymers and peptides. Other analyses performed in our lab include identification of unknowns, bio-diesel and chemical weapon analysis, and new thermal measurement and preparation techniques utilizing SNL microfabricated hotplates. These capabilities have wide-ranging application to bioscience research, and are in-house. A range of services from simple measurements to full collaborative research are available.

References:

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