Title: Forensically Deconstructing Marine Debris: Polymer and Plastic Additive Identification

Course Description:
In this comprehensive, hands-on course, participants will delve into the intricacies of plastic composition, contamination, and additive analysis to become proficient in reverse engineering and identifying unknown polymeric materials. This course is designed for a wide range of professionals—from academic researchers to plastic recyclers, polymer producers, and analytical instrument specialists—and provides a solid foundation in the theory and practice of forensic analysis of marine debris.

Key Learning Outcomes:

- Develop proficiency in identifying polymers using spectroscopic and thermal techniques.
- Explore gas chromatography and mass spectroscopy (GC/MS and pyrolysis-GC/MS) to detect and qualitatively analyze plastic additives.
- Experience a four-step method for analyzing complex, multilayer plastic composites in three dimensions.
- Understand marine debris's sources, composition, and environmental implications, and gain experience in real-world sampling and analysis.
- Strengthen problem-solving skills to support recycling initiatives, product redesign, and sustainable material management.

Instructional Approach:
The course is highly interactive, blending short, focused presentations with hands-on lab activities, instrument operation tutorials, and fieldwork. Participants will collect real-world samples, utilize advanced analytical instruments, engage in group discussions, and present their findings. A field trip to the Kalihi Plastic Recycling Research Facility (PRRF) and a beach sampling day add experiential depth to the learning process, ensuring that students gain theoretical knowledge and practical skills directly applicable to their professional contexts.

Sample Course Activities & Topics

Activity Type	Sample Topics & Exercises	Learning Objectives
Foundational Learning	- Introduction to marine plastic pollution - Laboratory safety training & instrument orientation - Participant introductions and goal setting	Gain a broad understanding of marine debris issues and learn how to operate analytical equipment safely
Fieldwork & Sample Collection	- Beach sampling expedition (e.g., Waimanalo Beach) for marine debris - On-site debris collection and initial sorting	Experience real-world sampling techniques, understand environmental contexts and gather materials for lab analysis
Facility Tours & Applied Research	- Visit the Plastic Recycling Research Facility (PRRF) - Examine recycling workflows & derelict fishing gear (DFG) sources	Observe industrial and research-scale recycling processes, learn about supply chain inputs, and identify potential engineering solutions
Polymer Identification Techniques	- Attenuated total reflectance fourier transform infrared spectroscopy (ATR-FTIR) fundamentals and DSC (Differential Scanning Calorimetry) basics - Transmission FTIR & micro-FTIR for multilayer composites - Integrative approaches to advanced polymer ID	Develop expertise in polymer characterization methods, interpreting spectral data, and applying these results to complex material structures

Additive Analysis & Advanced Instrumentation	- Solvent extraction methods for additive detection - GC/MS preparation and qualitative analysis - Py-GC/MS for additive detection and polymer refinement	Enhance skills in identifying and characterizing additives within polymers, gaining familiarity with a range of analytical techniques
Summative Discussion	- Group discussions on data interpretation - Student discussion of sample findings - Q&A sessions to consolidate learning and share insights	Reflect on results, practice scientific communication, and engage with peers to refine analytical reasoning and draw informed conclusions.