Mass Spectrometry Fundamentals: A Hands-on University Lab Course

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Mass spectrometers arguable comprise the consummate mix of physics, chemistry, engineering, and materials. Unfortunately, the "black box" approach to MS taught in most university programs fails to connect students with the inner workings of these amazing machines, portending an alarming decline in future innovations to drive this technology. Our proposed MS Fundamentals course address this concern by teaching students to design, build, and test their own miniature MS instruments in a single-semester laboratory class.

Using Simion to model and simulate new designs, the geometry is then implemented in printed circuit boards to form the physical instrument. Students, working in teams of 2-3, can thus simulate classical and novel MS instruments, translate the electrical boundary conditions using PCBs, and construct 3-D models by simply stacking boards together to form ion course, analyzer and detector volumes, and even gas-tight enclosures that replace traditional vacuum chambers. Ceramitron has fabricated scores of working MS units using this construction method. By eliminating virtually all of the discrete elements in favor of photolithographic metallization, we have drive the cost of MS prototyping down by nearly two orders of magnitude. Average unit cost: ~$60.

Four teams of three students each can design, fabricate, and test four different MS designs in a single class. Aggregating their designs into a single artwork allows an outside PCB fab shop to run them as a single batch, then dice the difference models, for a significant savings in setup charges. Optimally, each team would receive four identical copies of its design to test and evaluate. Total cost: < $2000

A number of universities are considering adopting this powerful teaching tool which could significantly drive development of compact, innovative MS devices suitable for remote and harsh operating environments.