

Ambient Ionization Mass Spectrometry

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Preface

A decade ago, it would have been unthinkable to hold an object in front of a mass spectrometer in open air and record mass spectra in real time. The DART was originally conceived as an atmospheric-pressure electron capture source for the analysis of volatile components with an ion-mobility spectrometer. In late 2002 and early 2003 when we pointed the newly constructed DART source toward the atmospheric pressure interface of a time-of-flight mass spectrometer, we realized that the DART was something new. We now had a way to measure mass spectra in real time for liquids, solids, and gases sampled directly.

After decades of dissolving and injecting samples into GC/MS and LC/MS systems or introducing materials into vacuum chambers, this was truly liberating! Now we could analyze almost anything instantaneously. We could not analyze *everything* directly, but the probability of getting useful information was high, and the amount of effort required to attempt the analysis was minimal. We began examining everything we could find, from foods and beverages to clothing and rubber tires.

Graham Cooks and I gave the first public presentations on DESI and DART in successive talks at the ASMS Sanibel Conference in Clearwater, FL in 2005. The topic that year was “MS in Forensic Science and Counterterrorism”. This was an exciting session. Not just one, but *two* new “ambient ionization” techniques appeared almost simultaneously!

The response to the commercial introduction of the JEOL AccuTOF-DART mass spectrometer at the Pittsburgh Conference two months later was enthusiastic. The DART won the PittCon Editors’ Gold Award for best new product. An R&D 100 Award followed and DART was featured on the television series “CSI: NY”. Within a short time, early adopters were finding a variety of innovative uses for the new technology.

Following the introduction of DESI and DART, a large number of new ambient ionization sources have been developed. The contributions to this book represent cutting-edge developments in ion-source design and applications.

A preface is an appropriate place to comment about the terminology used in this book. The term “ambient ionization” first appeared in the original 2004 DESI publication in *Science*. The novel aspect of both DESI and DART was that samples could be analyzed directly under *laboratory-ambient* conditions; that is, in open air. Therefore, we used the same term to describe DART, the other open-air ionization source at that time.

Terminology can be confusing. Being a stickler for the correct use of terminology, David Sparkman pointed out to me that the term “ambient” means “the surrounding environment” and that the ambient condition of a sample in vacuum is *vacuum*. By that definition, any ion source could be considered “ambient”! Nevertheless, it is understood that ambient ionization sources are all atmospheric-pressure ion sources.

“Direct analysis” refers to analysis of samples in their native state with little or no sample preparation. Direct analysis does not necessarily require ambient ionization. The term could just as easily refer to a direct insertion probe sample introduced into an electron ionization (EI) source in vacuum as long as the sample was analyzed in its native state.

Despite these concerns, the general understanding is that we are referring to “ambient ionization” as occurring under *laboratory-ambient* conditions. In the broadest sense, ambient ionization has come to mean *ionization at atmospheric pressure with little or no sample preparation*.

The information that we can obtain from an ambient ionization method depends on the information content that the mass spectrometer (and/or ion mobility spectrometer) can provide. High-resolution accurate-mass data and tandem mass spectrometry are valuable tools for extracting the maximum information from data obtained without the benefit of chromatography. Although it stretches the meaning of the term “ambient”, you will find that sample preparation methods and chromatography can be combined with many of the ion sources described in this book.

Ambient ionization is a rapidly growing topic within mass spectrometry. Even as this book nears completion, publications describing new ambient ionization methods have appeared in the literature. Given the “moving target” nature of an evolving technology, it is necessary to limit our goals and present a snapshot of the field at the time of publication. We have attempted to offer a wide variety of innovative approaches to instrumentation and chemical analysis presented by the leaders in the field. I have no doubt that we will continue to see exciting new developments in the years to come.

Robert B. Cody

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