

Highlights of Analytical Sciences in Switzerland

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Vaping with a Mass Spectrometer – On the Road to Profile all Chemicals in E-Cigarette Puffs in Minutes

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We set out to answer a simple question^[1] – what if we can measure the chemical composition in e-cigarette and cigarette puffs directly, without any liquid dilution, aerosol collection, or chemical modifications? In our recent publication employing our novel setup, we were able to take the first step towards characterizing a greater number of compounds from a greater range of chemical classes in minutes.

In the past two decades, there has been a staggering rise of popularity of electronic cigarettes (ECs), particularly in young adults. Coupled with targeted ad campaigns, its ease of concealment and frequent use has led to an unprecedented rise in smoking-related diseases in young people. This age-shift in the prevalence of these diseases has led to concerted efforts by organizations around the world to understand and regulate ECs. Several nations, including Taiwan, have outright banned the sale of ECs, while the US, EU, and Switzerland have several laws in place regulating various aspects of manufacturing, distribution, and advertisement of ECs.

The problem, we hypothesize, comes from being unaware of the harmful compounds coming out of ECs: the liquid composition is known, but the produced aerosols remain uncharted territory full of unknown compounds. We could not have comprehensively and rapidly investigated this with previously-established methods of detection.

Here, we developed a novel method to explore the chemical landscape of EC aerosols. This method allows us to extract

emissions directly from an EC or a burning cigarette and obtain a real-time profile on their composition. It combines the technologies of a dielectric barrier discharge ionization source, a high-resolution orbitrap mass spectrometer, and a state-of-the-art chemical informatics pipeline, alongside the use of cheap PTFE tubing and 3D printed adaptors. This essentially converted the mass spectrometer into a powerful nose, able to analyse as many compounds as the collective power of derivatization, adsorption tubes, filter pads, condensation under various ionization methods could (Fig. 1).

Furthermore, the analysis and interpretation of this large-scale chemical data were carried out using a combination of home-made and browser-based data analytical tools that have been developed and continuously refined over the last 20 years. These tools, some of which were described before,^[2] enabled efficient handling of complex mass spectrometry datasets, rapid identification of compound classes, and streamlined visualization of the chemical diversity present in the aerosols.

As a result, we were able to analyse a broader range of compound chemical classes in EC aerosols, from carbonyls, alcohols, esters, oxides, and nitriles, to aromatics, unsaturated and saturated hydrocarbons. A lot of these harmful substances uncovered in ECs were distinct from those we detected in cigarettes, unique in the chemistry behind their generation. This necessitates further investigations into the thermo-oxidative reactions that happen during EC aerosol generation.

We hope this setup, now available to be recreated by any lab, can serve as the first step in allowing researchers insights into the EC aerosol compounds that can affect human health, and potential solutions that can be deployed to eliminate the presence of said aerosolic compounds.

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[1] Y. Q. Gao, N. Gasilova, J.-C. Wolf, L. Patiny, L. Menin, M. Pavlou, *Anal. Sens.* **2025**, *5*, e20240079, <https://doi.org/10.1002/anse.202400079>.

[2] L. Patiny, *CHIMIA* **2025**, *79*, 66, <https://doi.org/10.2533/chimia.2025.66>.

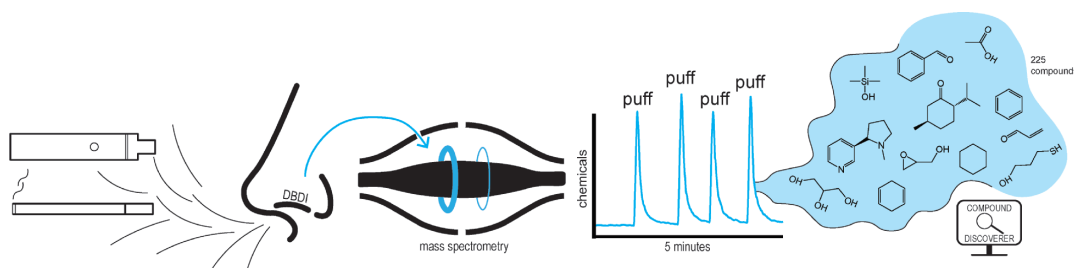


Fig. 1. A diagrammatic representation of the method introduced in our paper, depicting the chemical composition analyses of the (electronic) cigarette emissions directly from its generation.

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