# Non-destructive ambient MS imaging and differentiation of fingerprints directly from a smartphone with desorption electrospray ionization (DESI)

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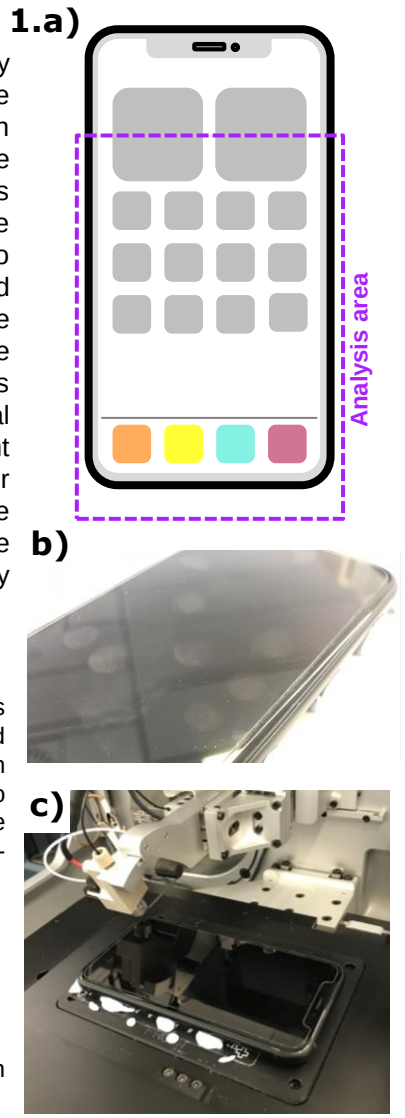
## Introduction

Mass spectrometry imaging (MSI) is mostly performed on small tissue samples that are typically no larger than 1 $cm^2$ in size. DESI is an ambient MSI technique that requires no sample pre-treatment and can conduct in-situ analysis with minimal to no damage. In this work, we utilized the large-area functionality of DESI to conduct MSI on the surface of a used smartphone. The area imaged covered the majority of the phone's surface, and the fingerprint patterns of three different individuals were differentiated by their unique chemical constituents. Using a quadruple time-of-flight (qTOF) mass spectrometer allowed faster acquisition scan rates, drastically reducing the amount of time to conduct the experiment. The smartphone was undamaged and fully operational after the analysis.

## Method

Three different individuals placed their fingerprints onto the surface of a smartphone and simulated access to various apps, as well as other actions such as swiping. The smartphone was then secured onto the DESI™ XS source stage and imaged with the High-Performance Sprayer on a Waters Xevo™ G2-XS qTOF MS (figure 1).

Ionization voltage- +0.7kV
MS scan rate- 10 Hz
DESI solvent- Methanol with 0.1% formic acid (v/v)
DESI scan area- 11.5 x 7.5 cm (86.25 $cm^2$)
Image pixel size- 100 µm x 100 µm
MS image processing visualization- Waters High Definition Imaging (HDI™) v1.6




## Results

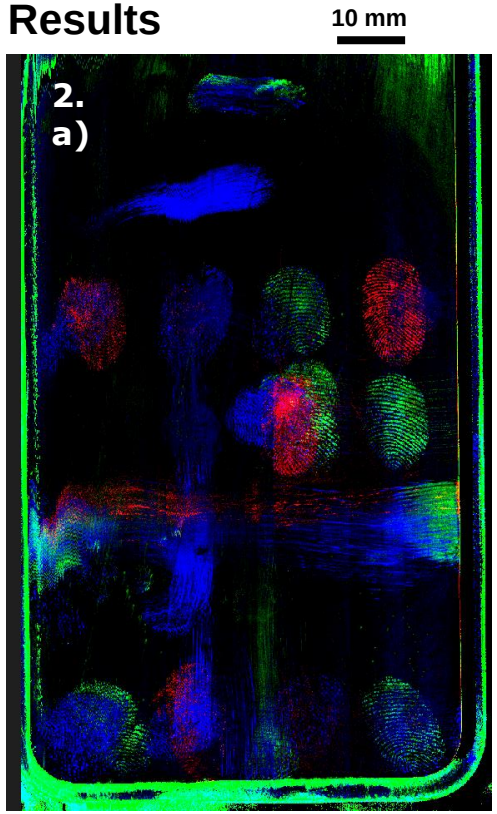
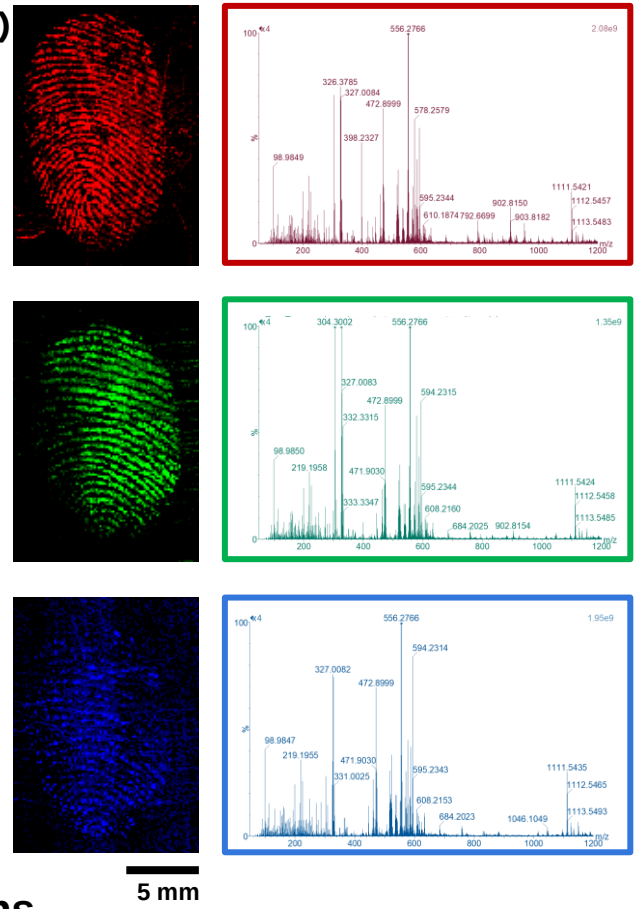



*Figure 1. a) schematic of imaged area on the front of the phone. b) photograph of the surface before analysis showing the location of the fingerprints. c) the phone mounted onto the DESI XS source stage for imaging.*




The DESI XS source imaged the large surface area of the smartphone within a single acquisition (Fig. 2.a). The ridge patterns of the fingerprints for each of the three individuals could clearly be seen using single-color images (Fig. 2.b). The mass spectra of the three different fingerprints showed unique peaks, which made up the chemometric profile of the three individuals. This differential profile could be used to work out the owner of other fingermarks on the phone; such as, the swipe actions visualized as the smudges across the phone's surface. After the experiment, the smartphone was returned to the owner and functioned normally.

*Figure 2. a) Overlayed MS images of three different masses (Green m/z 298.3, Blue m/z 325.1, Red m/z 902.7) showing the spatial distribution fingermarks belonging to the three individuals).*
*b) Enlarged images of complete fingerprints showing clear ridge patterns for the three individuals, as well as their corresponding extracted MS spectra.*

## Conclusions

Large area MS imaging of a smartphone was successfully conducted with DESI. The imaging area was more than 85 times the size of a typical MS imaging experiment.
The high scan rate (10 Hz) of the mass spectrometer allowed the image to be acquired within a reasonable timeframe (around 26 hours).
The image was conducted at 100 µm pixel size and showed clear ridge patterns for the fingerprints.
The ambient, non-destructive nature of the DESI allowed the smartphone to be examined and returned to normal usage afterwards.