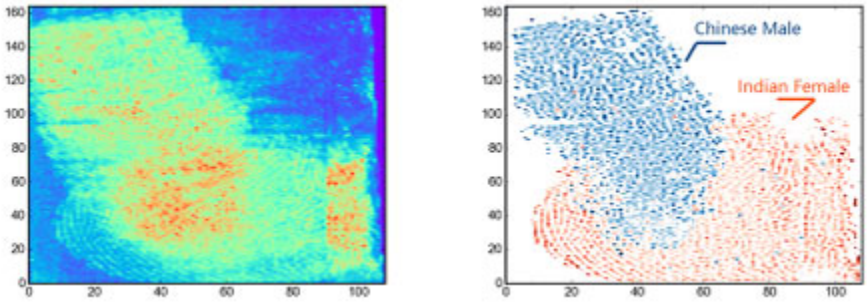
Docket #: S16-400

Mass Spectrometry Imaging for Enhanced Fingerprint or Sweat Analysis

Researchers in Prof. Richard Zare's laboratory have developed a fast, accurate mass spectrometry technique for distinguishing an individual's gender, age or ethnicity based on the chemical composition of sweat. This invention utilizes desorption electrospray mass spectroscopy imaging (DESI-MSI) to analyze both the fingerprint pattern and the composition of lipids and other metabolites from the sweat on the print. Next, a machine learning model (gradient boosting tree ensemble) further classifies the sample and predicts at a range of personal characteristics based on the DESI-MSI profile. Initial studies have correlated patterns of metabolites in sweat with age, gender and ethnicity. The model could be expanded to classify by medical condition or drug usage and it could be used to classify sweat samples collected alone without fingerprints. This invention could be a powerful tool to harness the enormous amount of chemical information provided by mass spectrometry for forensic or diagnostic testing.



Results of fingerprint imaging and classification

(A) negative ion mode DESI-MSI ion images of m/z 253 of two fingerprints; (B) correct predictions for the samples, showing blue pixels that were predicted to be

belong to a Chinese male and red pixels that were predicted to be from an Indian female.

Stage of Research
The inventors applied the classification algorithm to analyze lipid profiles on samples from 203 individuals and classified their gender, ethnicity and age (by decade) with 89.2%, 82.4% and 84.3% accuracy respectively. They demonstrated proof-of-concept by using the model to accurately predict gender and ethnicity of two overlaid latent fingerprints, while also achieving better separation.

Applications

- **Forensic analysis** - enhanced fingerprint analysis to predict an individual's class (e.g., gender, age, ethnicity, drug use, medical condition) based on the chemical composition of sweat
- **Diagnostics** - potential for adapting analysis to identify individuals with a disease that alters chemical composition of the patient's sweat (e.g., cystic fibrosis or cardiovascular disease)

Advantages

- **Enhanced information content** - single analysis to for both fingerprint imaging and chemical classification to predict additional characteristics such as age, ethnicity, gender or disease state
- **Non-invasive sample collection** - analysis can be performed on latent fingerprints or from a sweat sample collected by rubbing a glass slide or other suitable material on skin (no need to induce sweating)
- **Fast, high accuracy results:**
    - DESI-MSI can provide information on a wide range of metabolites in ~2 hours
    - demonstrated over 80% accuracy at predicting age, ethnicity and gender
    - better separation of features on overlapping fingerprints

Publications

- Zhou, Z., & Zare, R. N. (2017). "Personal Information from Latent Fingerprints Using Desorption Electrospray Ionization Mass Spectrometry and Machine Learning." *Analytical Chemistry*, 2017, 89 (2), pp 1369–1372.

Patents

- Issued: 11,416,704 (USA)

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