Imperial College London

Polymer Modified Surfaces Improve Detection of Colorectal Cancer Biomarkers Using LD-REIMS

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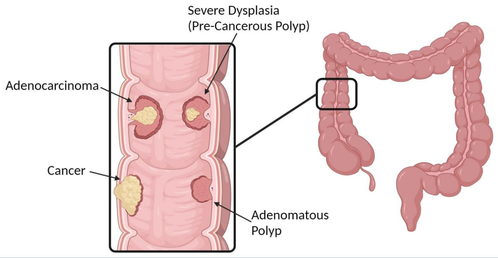
Introduction

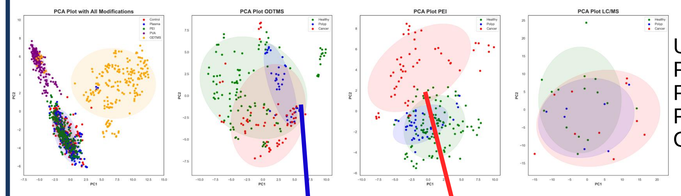
Colorectal Cancer (**CRC**) is the second leading cause of cancer **mortality** largely due to **late diagnosis.**

Current population screening test (**FIT**) lack the sensitivity for diagnosis of early-stage cancer and adenomas.

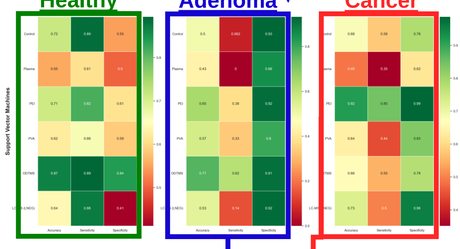
We propose the use of high throughput **ambient ionisation mass spectrometry** with **polymer modified surfaces** for the detection of metabolites related to colorectal **adenomas** and **cancer**.



Surface Modification



Unmodified
Plasma
PEI
PVA
ODTMS

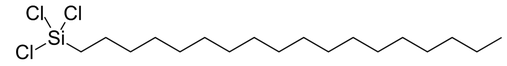


Several surface modifications were tested.

Best separation of **Cancer** disease state was observed using **PEI** modified surfaces.

Best separation of **Adenoma** disease state was observed using **ODTMS** modified surfaces.

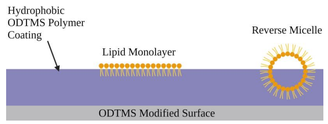
Healthy vs. Adenoma: Octadecyltrichlorosilane (ODTMS)

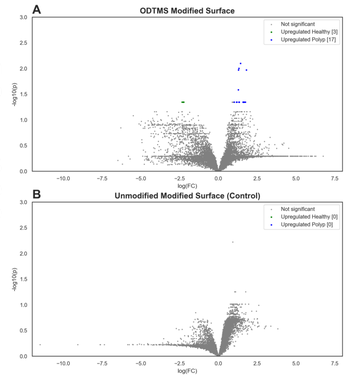


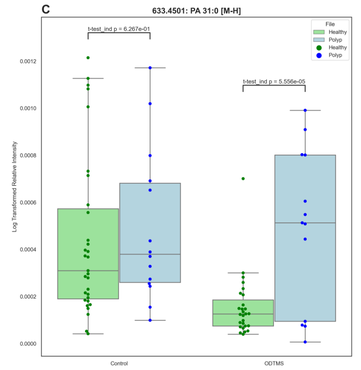
ODTMS separates **Healthy** and **Adenoma** samples.

20 features driving the separation with ODTMS modification, compared to **0 features** on unmodified surfaces.

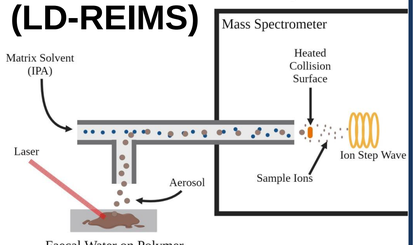
Interaction between lipids and ODTMS is still unclear. The lipids could be forming monolayers or reverse micelles.







Laser Desorption – Rapid Evaporative Ionisation Mass Spectrometry **(LD-REIMS)**



Mass Spectrometer:
Waters Xevo QTOF G2S Mass spectrometer

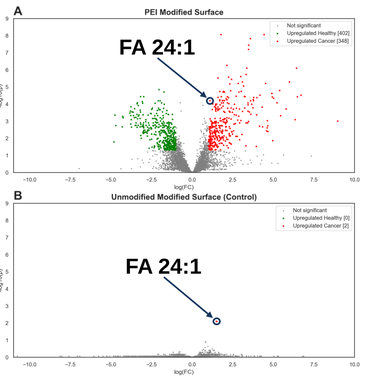
Laser:
Opotek Q-switched optical parametric oscillator (OPO) laser source

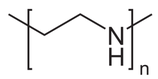
Faecal water was added to sampling surface.

Sample Demographics:
15 Healthy samples
7 Colorectal Adenoma samples
10 Colorectal Cancer samples

Ethical Approval: (REC: 14/EE/0024)

Healthy vs. Cancer: Polyethylenimine (PEI)





FA 24:1 is detected in all experiments. **REIMS** (modified and unmodified surfaces) and **LC/MS**.

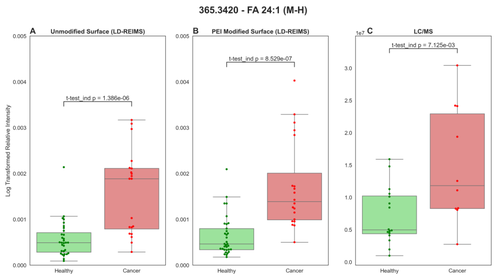
In all tests it is found to be statistically higher in ↑**Cancer** than ↓ **Healthy**.

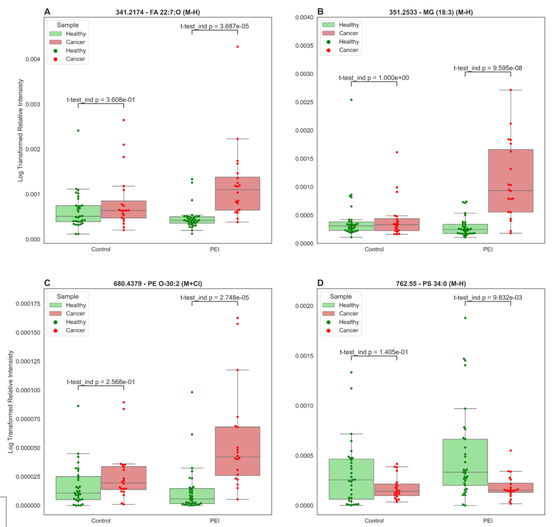
Separation is still most pronounced using LD-REIMS on **PEI modified surfaces**.

PEI modified surfaces separate between **Healthy** and **Cancer** disease states.

PEI modified surfaces have **750** statistically significant features driving separation.

Unmodified surfaces have **1** statistically significant feature (and its isotope).





While FA 24:1 is detected in all tests several features are only seen on the PEI modified surfaces.

PEI is known to associate with lipids and is often used as an attachment factor in cell culturing.

26 metabolites were identified and annotated as driving separation of Healthy and Cancer using PEI modified surfaces.

Identified Metabolite	LD-REIMS m/z	Cancer vs. Healthy
FA 15:4 [M-H]-	233.1536	Healthy ↑
Pentadeca-3,5,7-trienedioic acid [M-H]-	265.1476	Cancer ↑
FA 18:2 [M-H]-	279.2330	Healthy ↑
FA 18:0;O [M-H]-	299.2591	Healthy ↑
FA 19:3;O2 [M-H]-	323.2229	Cancer ↑
FA 22:2 [M-H]-	335.2949	Cancer ↑
FA 22:7;O [M-H]-	341.2174	Cancer ↑
MG(18:3) [M-H]-	351.2533	Cancer ↑
FA 24:2 [M-H]-	363.3268	Cancer ↑
FA 24:1 [M-H]-	365.3419	Cancer ↑
FA 27:12;O [M-H]-	401.2147	Cancer ↑
FAHFA 33:0;O [M-H]-	523.4728	Healthy ↑
FAHFA 34:0;O [M-H]-	537.4885	Healthy ↑
FAHFA 36:1;O [M-H]-	563.5032	Healthy ↑
Vitamin D2 3-glucuronide [M+Cl]-	607.3506	Cancer ↑
SM(30:1) [M-H$_2$0-H]-	627.5009	Cancer ↑
PE 30:0 [M-H]-	662.4778	Cancer ↑
PE O-30:2 [M+Cl]-	680.4379	Cancer ↑
DG(18:0/0:0/22:5-O) [M-H]-	683.5267	Cancer ↑
PE 32:0 [M-H]-	690.5005	Cancer ↑
PA 36:6 [M-H]-	691.4221	Cancer ↑
GlcCer(d18:1/16:0) [M-H]-	698.5707	Cancer ↑
PE 33:1 [M-H]-	702.5131	Cancer ↑
PE 33:0 [M-H]-	704.5206	Cancer ↑
PE 34:1 [M-H]-	716.5223	Cancer ↑
PS 34:0 [M-H]-	762.5367	Healthy ↑

Conclusions

Surface modification improved the detection of metabolites associated with colorectal cancer.

Combining the surface modification with ambient mass spectrometry allows for high throughput analysis of clinical samples.

As different modifications are used for the capture of specific metabolites future work will involve the development of an array with multiple modifications to streamline data acquisition and analysis.

This research can be applied in the development of new population screening tests, capable of detecting colorectal cancer earlier and improving patient prognosis.

BRITISH MASS SPECTROMETRY SOCIETY

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← Full Demographics and Methodology

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