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Polymers for Mass-Sensitive Sensors: Towards Electronic Skin

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Introduction

- Electronic skin (e-skin) is flexible, multi-sensing device that aims to imitate the human skin.
- E-skin has a high potential for applications in robotics and prosthetics and in/as diagnostic tool.
- One of the important features of the e-skin is the ability to absorb volatile organic compounds (VOCs) and to distinguish between them in a wide range of concentrations.

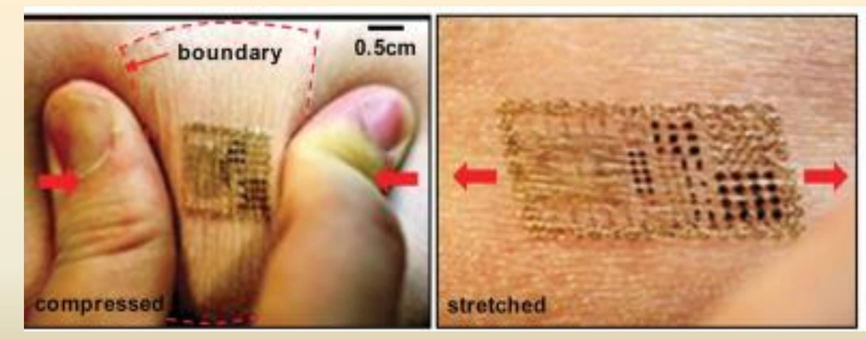

Figure 1. A prototype of Electronic skin

Objective

The ultimate objective of the present study is to examine the mass sensitivity of unique polymers, which has high potential to serve as components in e-skin, towards polar and nonpolar VOCs.

Methods and Materials

Preparation of solutions of the polymers in Figure 2.

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Coating three different (semiconducting) polymer on quartz crystal (Figure 3)

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Exposure of the polymer-coated crystals to eight different VOCs (Figure 2) at five different concentrations (Pa/Po), using the Quartz Crystal Microbalance (QCM).

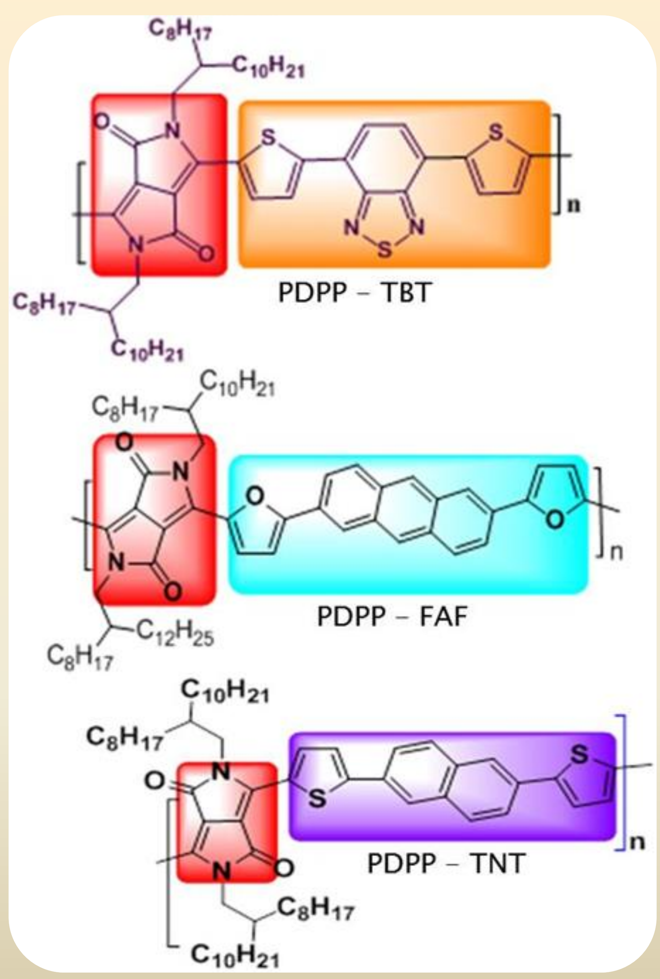

Figure 2. The studied polymers

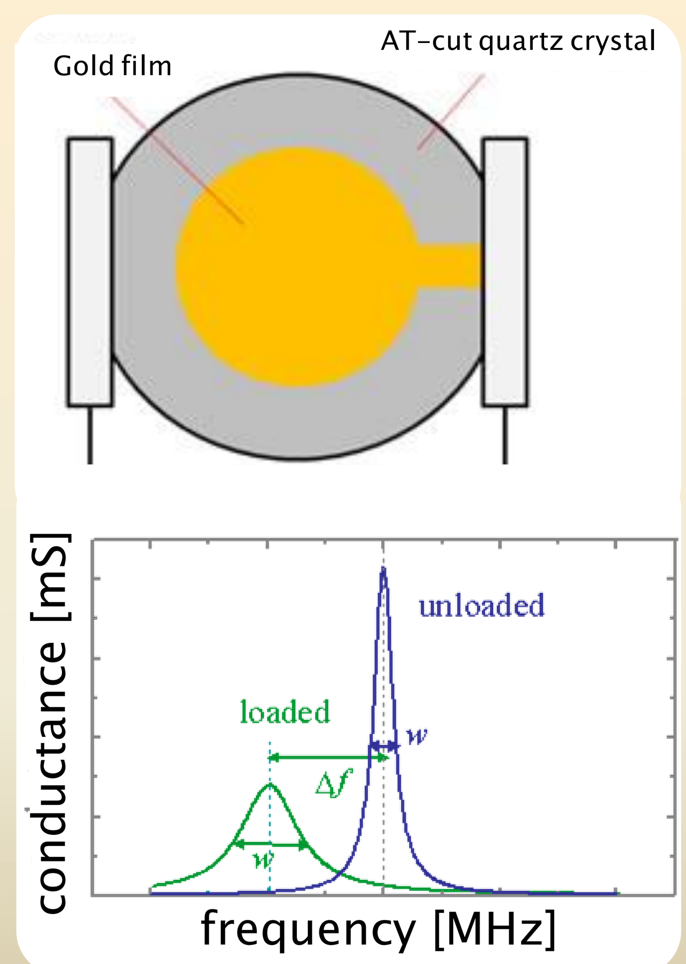

Figure 3 . Schematics of QCM

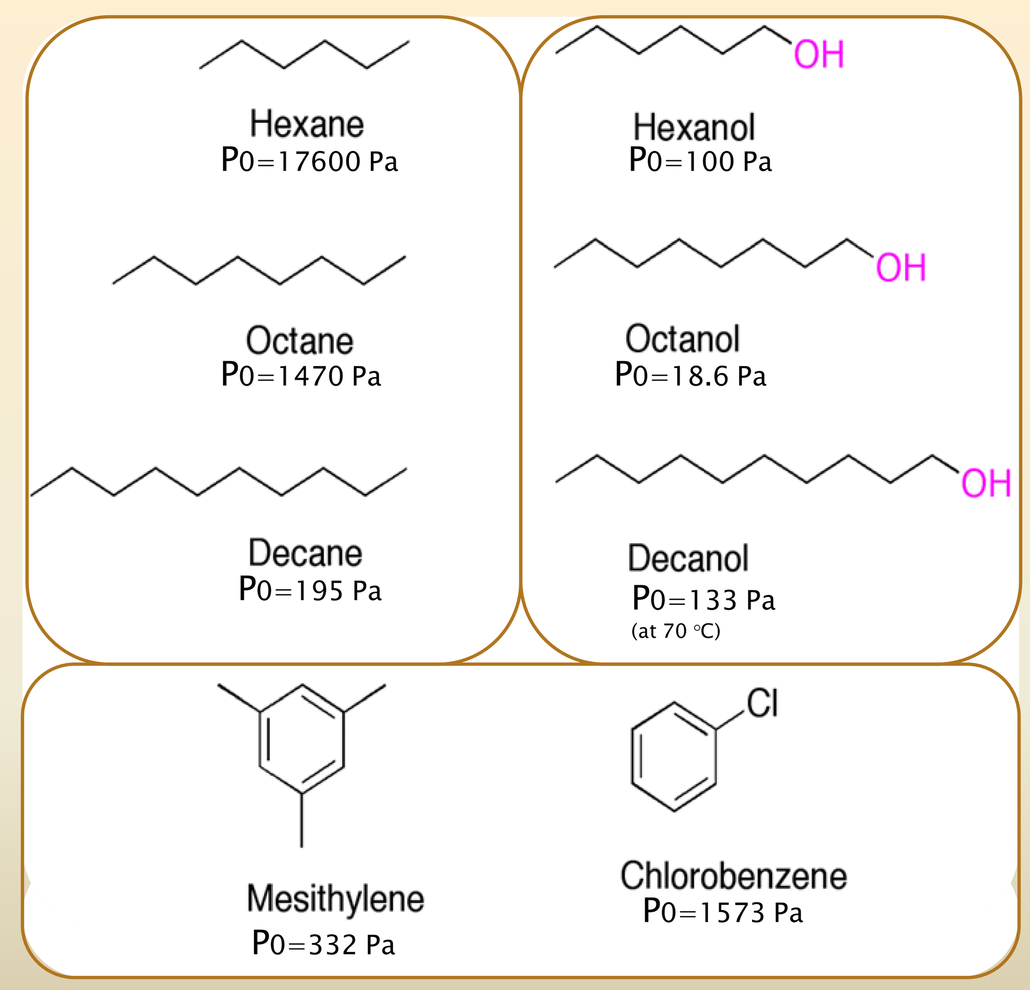

Figure 4. The examined VOCs

Results

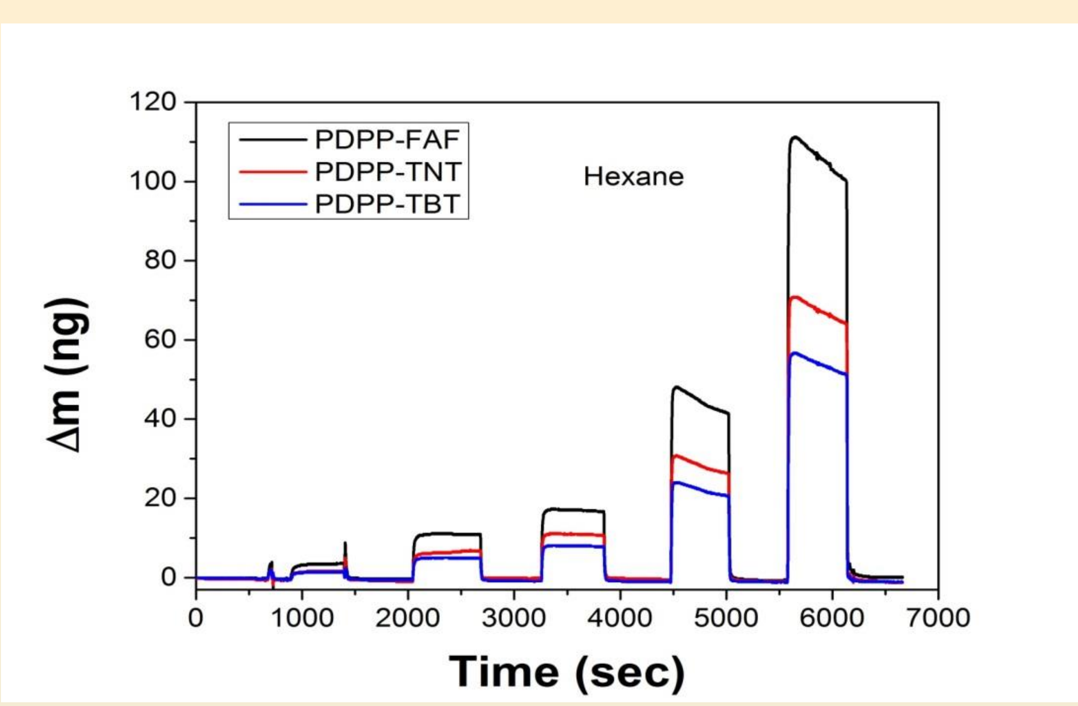

Figure 5. Mass shift for Hexane at different concentration

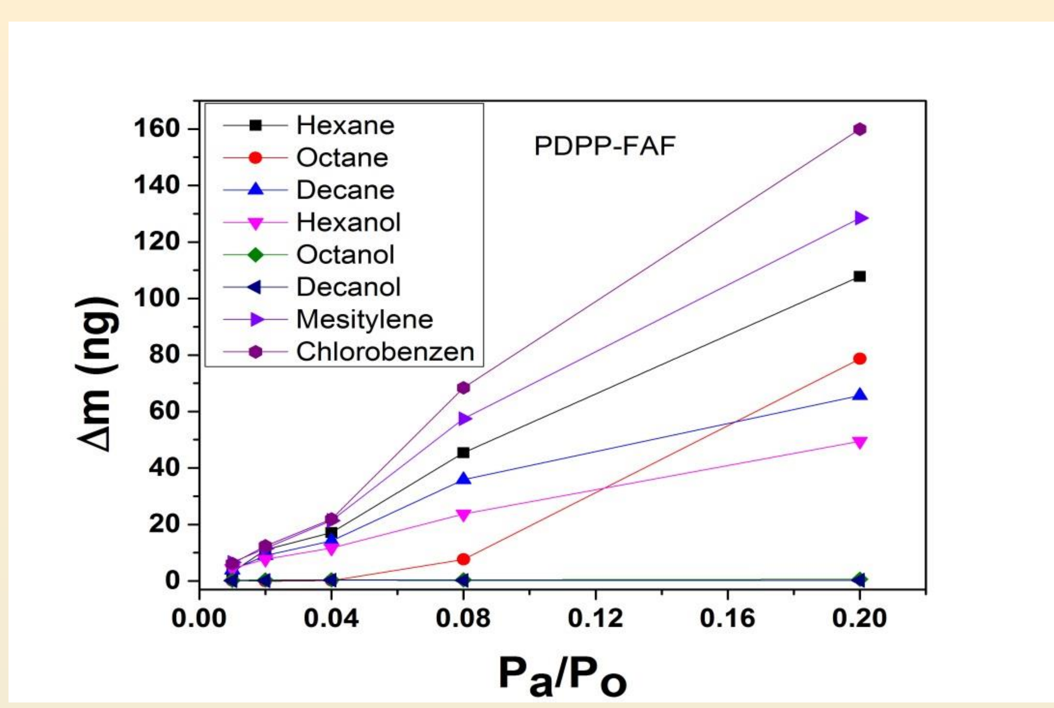

Figure 6. Mass shift for QCM coated with PDPP-FAF

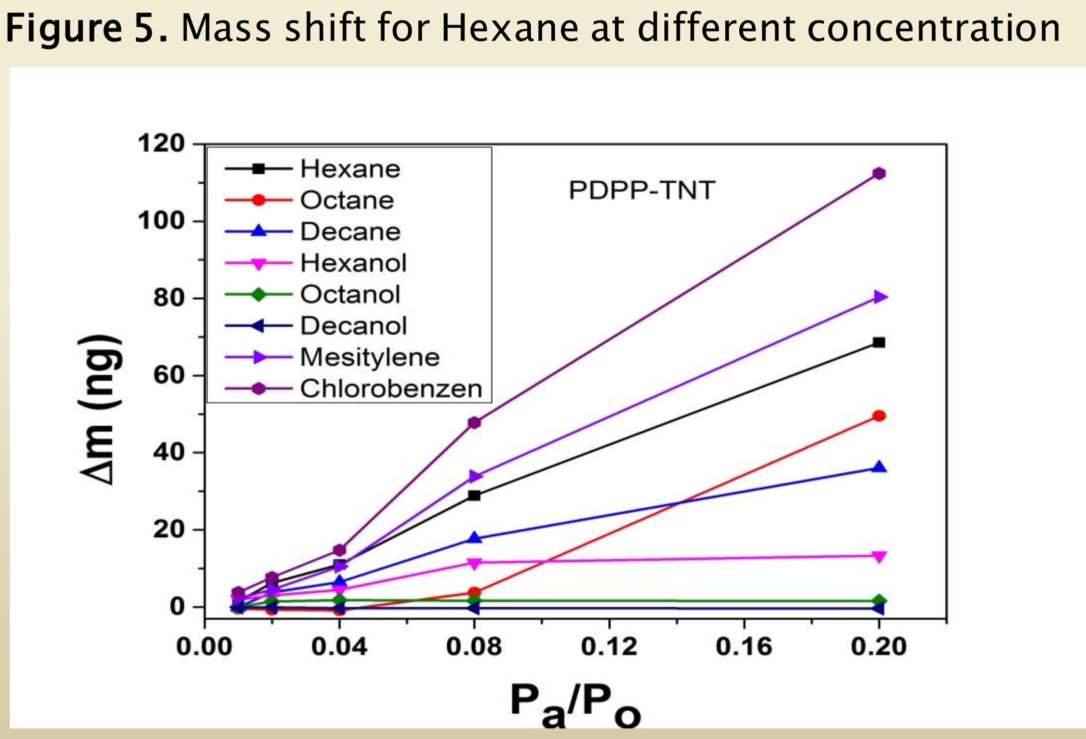

Figure 7. Mass shift for a QCM coated with PDPP-TNT

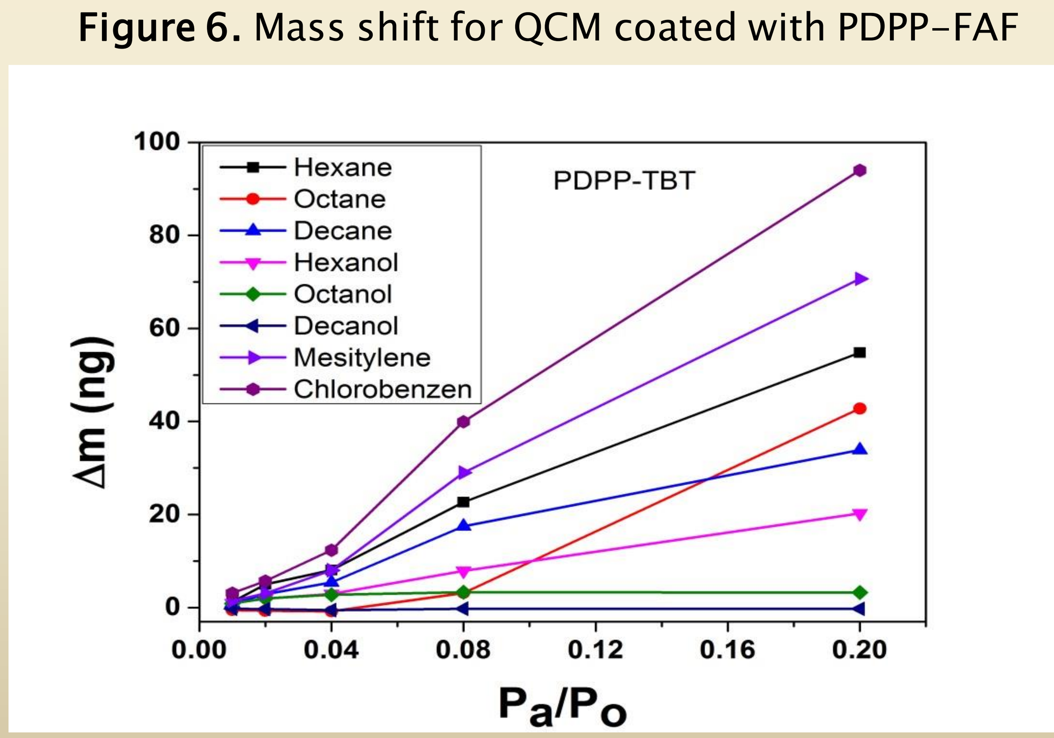

Figure 8. Mass shift for a QCM coated with PDPP-TBT

Discussion

- The sensor coated with PDPP-FAF had the highest response towards VOCs.
- The higher is the vapor pressure of the VOC the higher the mass absorption within the polymeric film.
- Aromatic Hydrocarbons (mesithylene and chlorobenzene) seems to attach very well to the main chain of polymer and, therefore, cause high responses.
- The mass changes caused by alkanes (hexane, octane, decane) are somewhere in the middle, most probably because of Van Der Waals interactions with the side chain of polymers.
- The responses caused by the alcohols (hexanol, octanol, decanol) are least, probably because the weak interaction between polar alcohols and nonpolar side chain of polymers. Alcohols that have low vapor pressure do not pass the detection limit of the QCM sensors.

Conclusions

Our study indicates that the absorption of the VOCs depends on the structure of the polymer as well as on the chemical nature of the VOCs (*e.g.*, structure and vapor pressure). These findings could be very useful for the development of electronic skin that can sense a wide range of VOCs, side-by-side to other constituent features (e.g., sensing pressure, humidity and temperature).

Acknowledgments

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