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beside the smell
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Study of Room Temperature Ionic Liquids for sensing material in Quartz Crystal microbalances gas sensors

Research on gas sensors tries to improve selectivity, sensitivity, and stability. One of the more straightforward ways of improving the sensors is to investigate new sensing materials. One type of these new sensing materials is Room Temperature Ionic Liquids (RTIL). RTILs are salts that remain liquid at room temperature [1] and in general, have several advantages as gas sensing materials; they are stable and have low volatility which can decrease the effects of drift or sensor poisoning. They have been studied as stationary phases in gas chromatography and in a few applications as sensing film in gravimetric Quartz Crystal Microbalance (QCM) gas sensors [2] where they have shown their potential in that application.
As a proof of concept four RTILs were deposited on the QCMs by dip coating. Figure 1 and Table 1 summarize the fabrication procedure.

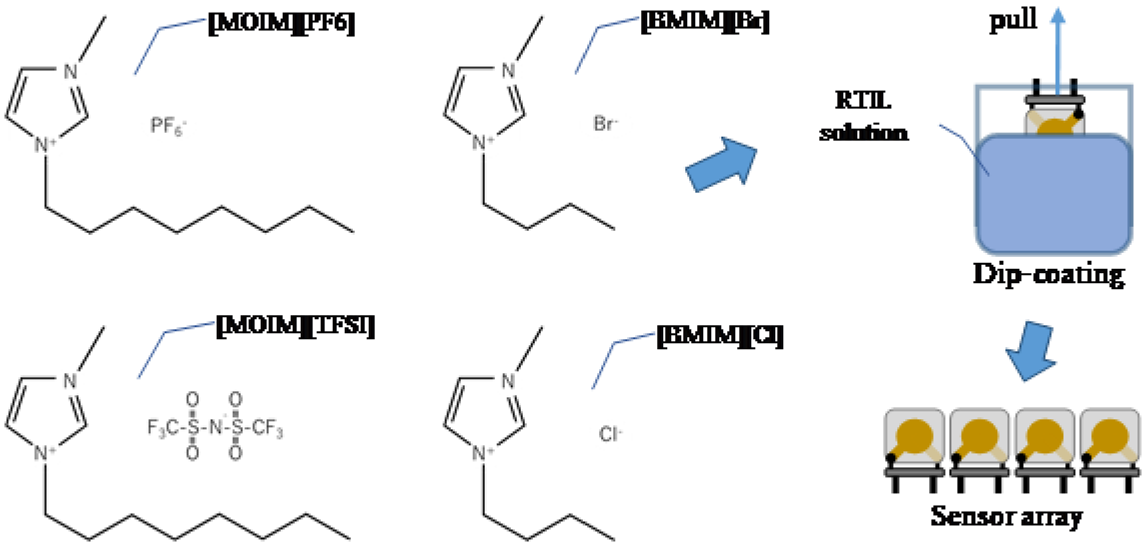

Figure 1. Four QCMs and the four RTILs that form the array sensor. Four Ionic liquids were dissolved according to the parameters in table 1. Then, four 9 MHz AT-cut QCM devices were dip-coated by submerging the QCM in the solution and pulling them out of the solution at constant speed. Finally, the sensors were placed together to form the final sensor array.

Table 1. QCM coating used in this paper

Sensor	S1	S2	S3	S4
Coating Material	[MOIM][TFSI]	[MOIM][PF6]	[BMIM][Cl]	[BMIM][Br]
Solvent	Acetone	Acetone	Chloroform	Chloroform
Concentration (gr/ml)	0.0203	0.0147	0.0100	0.0104
Deep coating speed (μm/s)	50	50	50	50
Δ Fs (Hz)	2264	1277	3486	2460

The sensors were measured by using techniques developed in the laboratory. Vector Network Analyzers (model DG8SAQ VNWA v3) were used to measure the conductance curves and extract the resistance and resonant frequency of the sensors. The responses to different gasses were recorded by a custom computer program made in Matlab. This software also controlled the hardware used to generate the gasses and send them to the sensors. Thus the measurement system was a fully automated [3]. Figure 2 shows a schematics of the system.

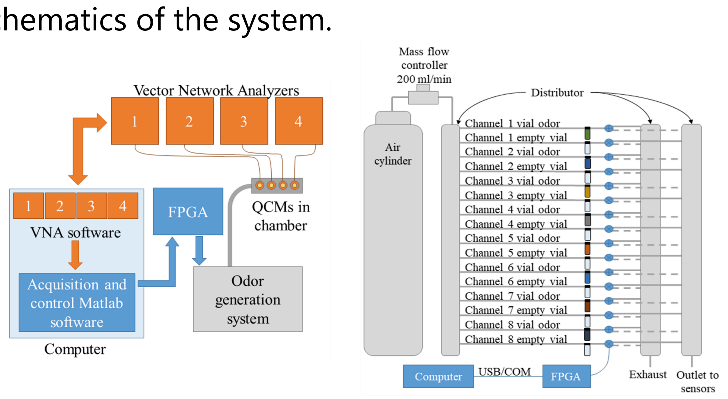

Figure 2. Scheme of the measurement (left) and odor generation system (right). The system allows the simultaneous measurement of resonant frequency and resistance of four QCM sensors. The odor generation system has eight channels that generate scents at different concentrations by passing a constant flow through vials containing odorant liquids.
The array was used to measure three different odorant gasses; hexanol, hexanoic acid and 2-hexanone with the same number of carbon atoms. In Figure 3 the Principal Component Analysis plot of the sensor responses shows that the sensor array can differentiate the three gasses despite having similar molecular weights.

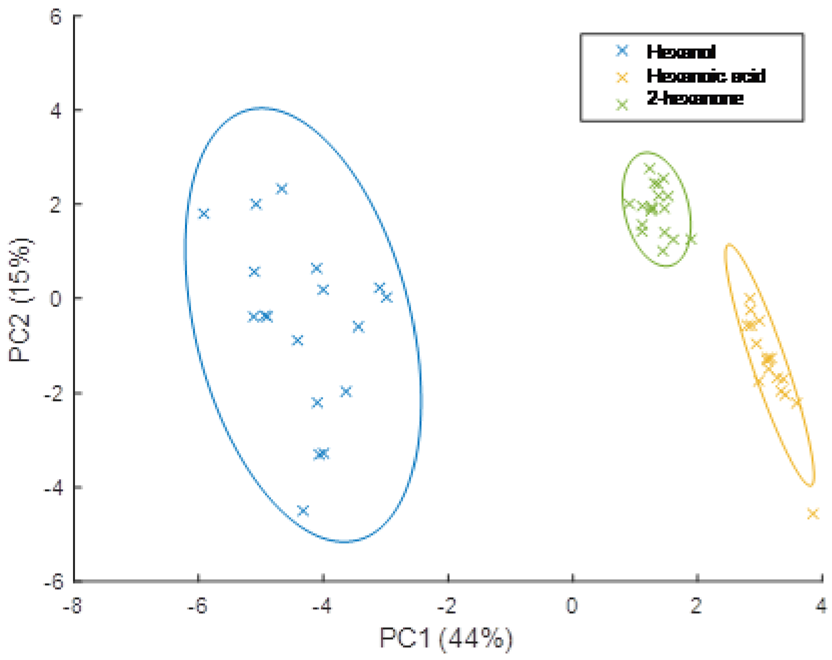

Figure 3. PCA plot of the measurements.

Reference

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2. Xu, X.; Li, C.; Pei, K.; Zhao, K.; Zhao, Z.K.; Li, H. Ionic liquids used as QCM coating materials for the detection of alcohols. Sensors Actuators B Chem. 2008, 134, 258–265. doi:10.1016/J.SNB.2008.04.039.
3. Aleixandre, M.; Nakazawa, K.; Nakamoto, T. Optimization of Modulation Methods for Solenoid Valves to Realize an Odor Generation System. Sensors 2019, 19, 4009. doi:10.3390/s19184009.

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