Sniffing-Out Life-Threatening Diseases with Transistors

The Detection of Acetone Vapours by SnO_2 Thin Film Transistors (TFTs)

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1. Background

Sniffer dogs help to diagnose life-threatening diseases such as **Parkinsons, diabetes** and **cancer** without the need for **invasive procedures** and **long waiting times.**

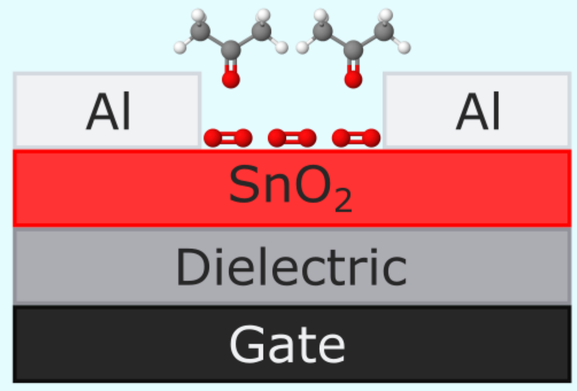
A canine's nose is capable of detecting tiny traces of the odours created by different diseases in our breath – **the equivalent of one teaspoon of sugar in two Olympic sized swimming pools.**

Thin film transistors (TFTs) can function as **electronic noses**.

2. Transistor fabrication

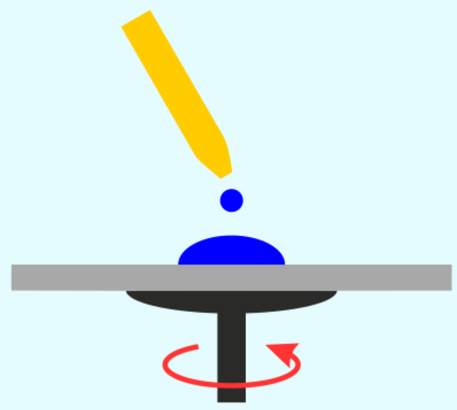
TFTs are three terminal devices that are essential components of all modern electronics.

Figure 1: Schematic of a SnO_2 TFT



Sustainable processing methods

Layers in the device stack are deposited using a versatile, fast and low-cost fabrication method

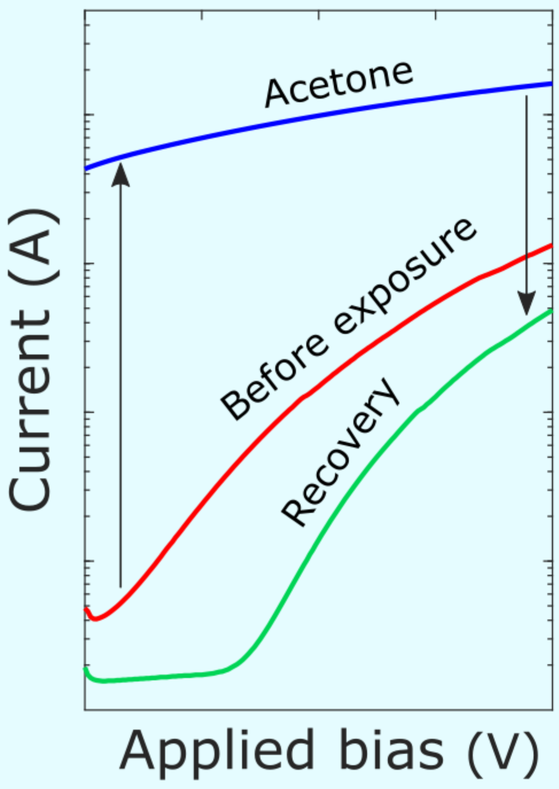


The SnO_2 solution is **spin coated** and placed on a hot plate for **1 hour** at different temperatures

The TFT is **no bigger than a 50p coin**

3. Acetone sensing in air

Figure 2: Current measured after exposure to acetone



Earth abundant materials

The incorporation of SnO_2 as the active semiconductor could eliminate the dependance on expensive rare earth metal oxides e.g. In_2O_3

Acetone vapours react with reduced O_2 species adsorbed to the surface of the SnO_2 film to release **free electrons**[1].

$$C_3H_6O + 8O^{2-} \longrightarrow 3CO_2 + 3H_2O + 16e^-$$

Current **increases** and is recovered after heating the device for **1 hour** at **100 °C.**

4. Transistors save lives

Acetone is an example of a **volatile organic compound** and over a thousand of these compounds are found in our breath.

The concentration of acetone exceeds **1.8 ppm** for a diabetic patient[2].

The **rapid** detection of acetone in our breath by a **portable** device is beneficial for the **real-time** diagnosis of **diabetes.**

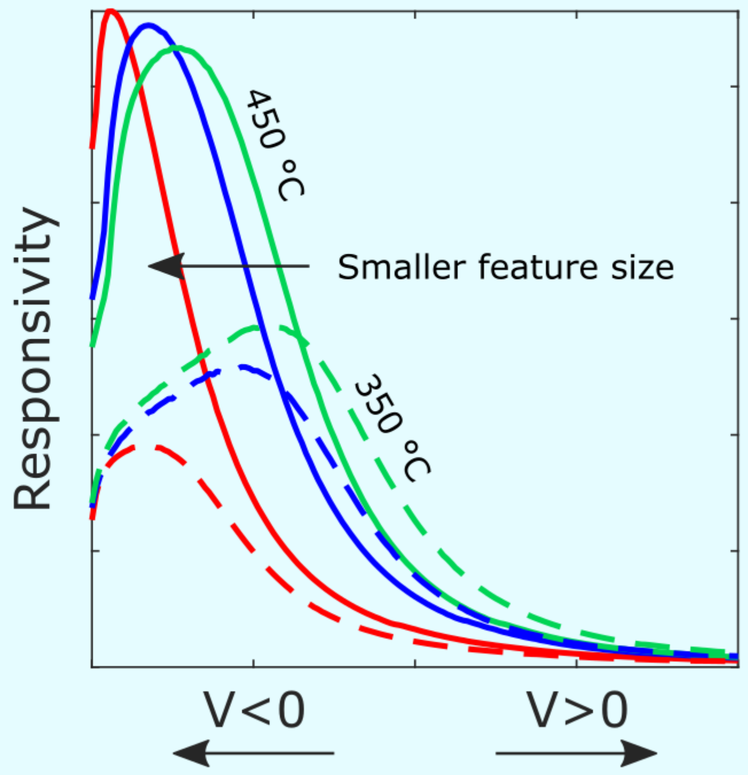
Responsivity is the **relative change** of the current measured following exposure to acetone vapours.

Responsivity is maximized at **negative applied bias (V<0).**

The SnO_2 TFT treated at **450 °C** is more responsive to acetone vapours.

Smaller feature size promotes electron transfer between SnO_2 and acetone.

Figure 3: Responsivity of the TFTs



STEM for BRITAIN

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[1] H. Windischmann, P. Mark, J. Electrochem. Soc. 126, 627–633 (1979)
[2] P. Harrison, M. J. Willett, Nature 332, 337–339 (1988)

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