Improving the accuracy of defect mobilities and observing interface effects of resistive switching memories using the current transient phenomenon

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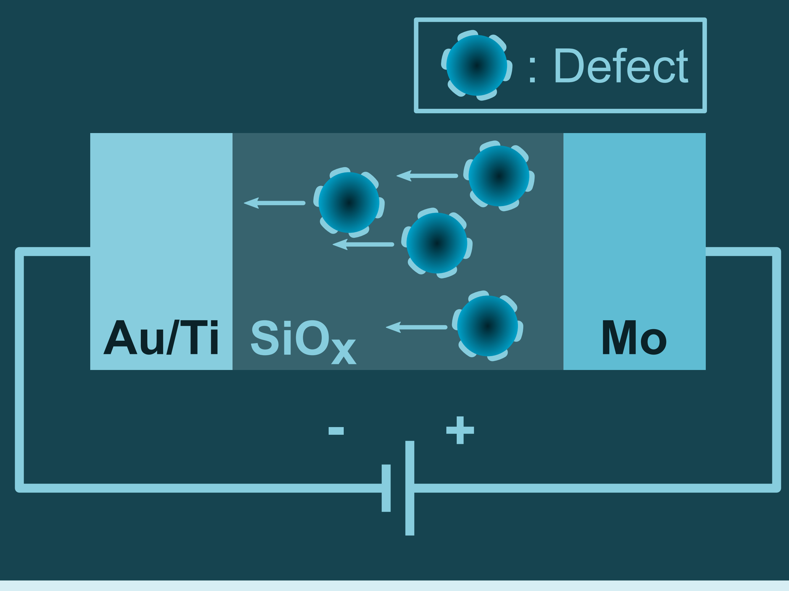
1. Motivation

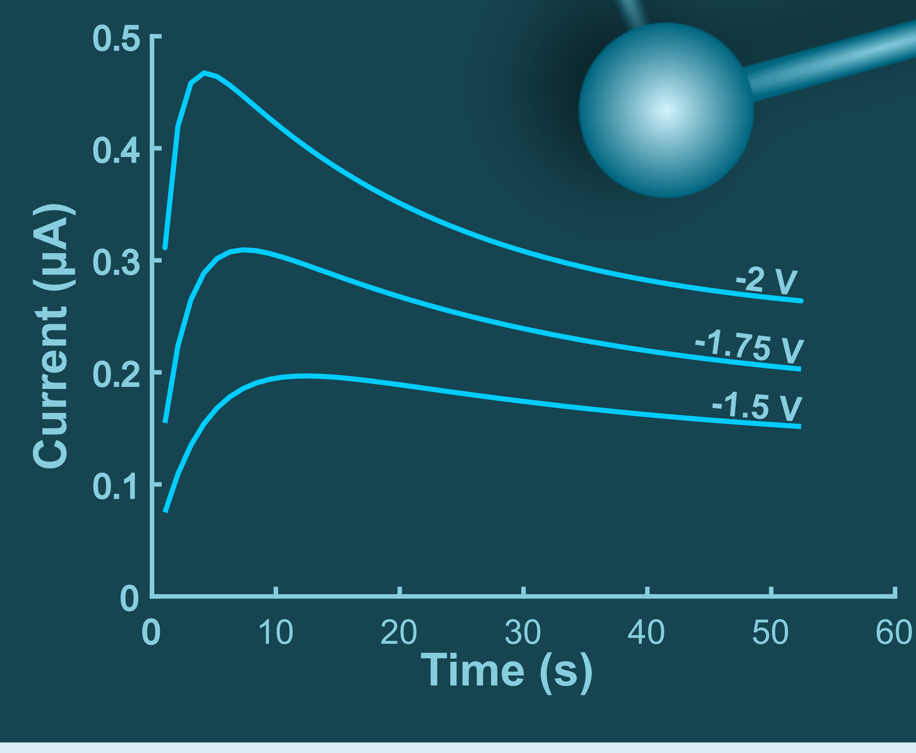
- High density **switching memories**, hardware accelerators and **neuromorphic** circuits frequently rely on resistive switching devices or **memristors**.

- These behaviours arise from the **motion of oxygen vacancies** within the oxide. It is therefore crucial we understand their **properties**.

- One possible method to observe vacancy properties is via a phenomenon called the **current transient** – a characteristic current time response with a prominent current peak.

- We present **new techniques** to observe and characterise such transients. With the aim **to verify** whether **vacancy properties** can indeed be determined from transients and if so, in what way?





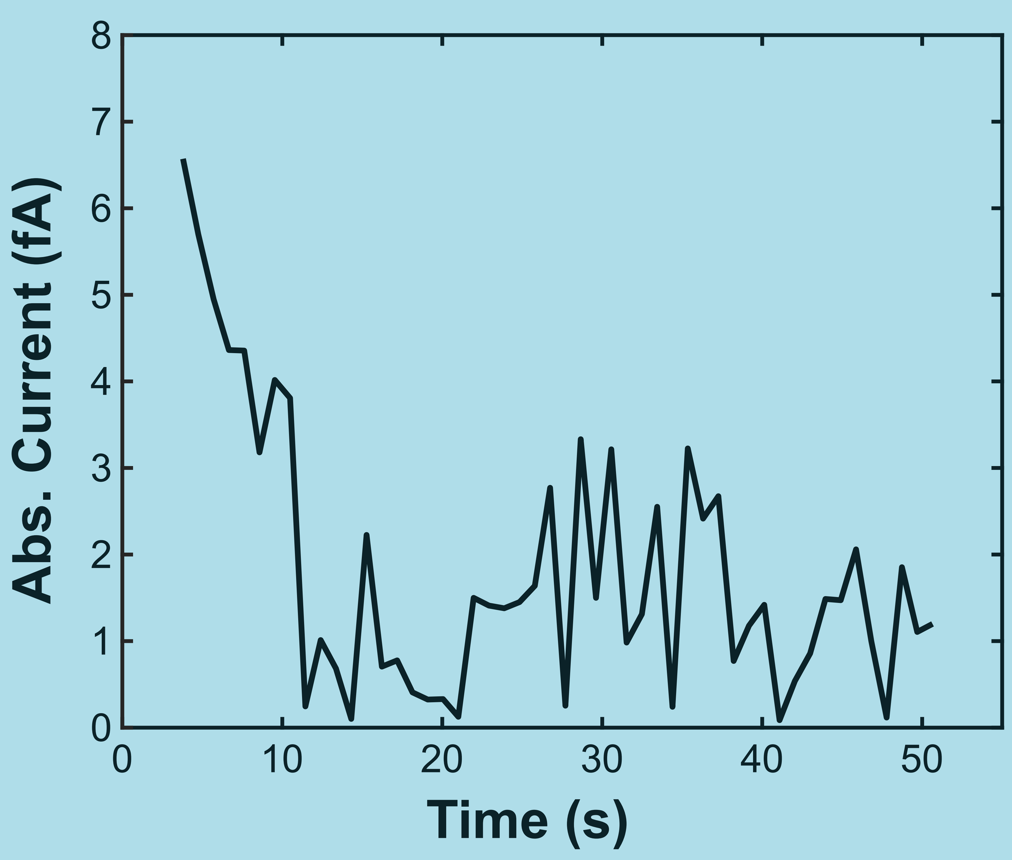
2. Inducing Transients

- The first challenge was to **reliably observe** transients in newly fabricated devices. Previously they had only been observed in defective devices.

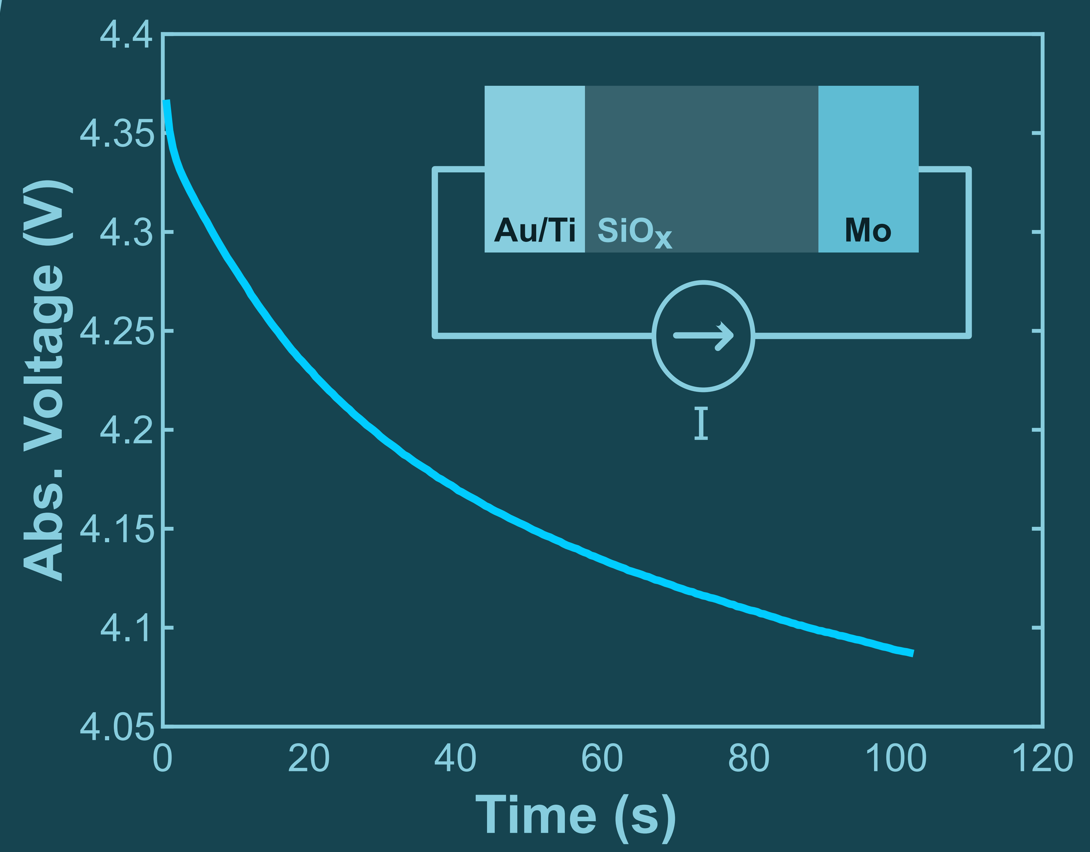
- We developed a **stressing** procedure to induce current transients in devices which involved driving a **constant current** through the device.

- With the ability to induce transients we now turn to their analysis.

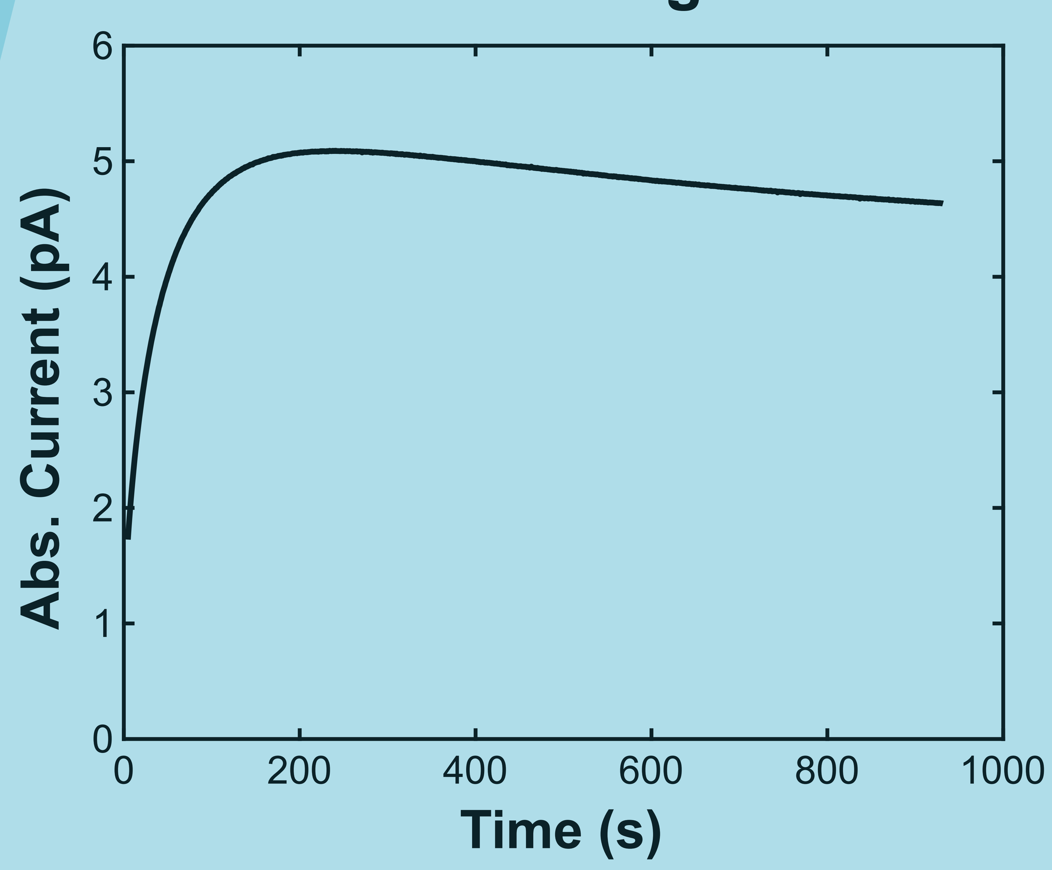
Pristine



Stressing



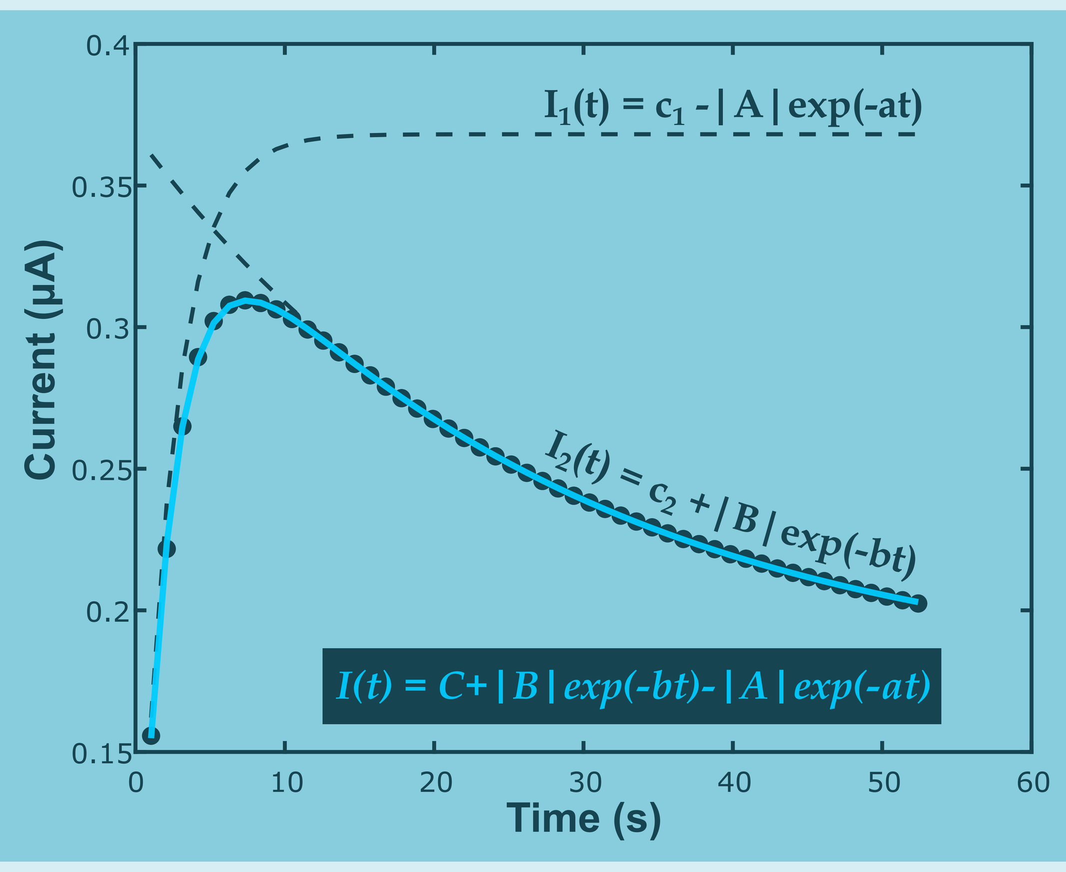
Post-Stressing



3. A Different Analysis

- In existing studies the analysis is based on the timing of the current peak. However, we have developed an alternative method based on our hypothesis that the transient is caused by two separate changes in the oxide.

- We instead fit the transient to **two exponential** functions allowing us to quantify the **rates** of the transient in greater detail.



- With readily observable transients and an insightful analytical approach we have gained further insight into the causes of the transients and their properties:

1. The behaviour is most likely the combination of two separate changes occurring in the oxide.

2. Only one of these changes seems the result of vacancy migration, the other being charge injection. Previous methods of calculating vacancy mobilities may therefore need re-evaluating.

4. Summary & Outlook

- We have presented **novel experimental techniques** and **analytical tools** to characterise the transients in greater detail.

- This gained understanding encourages us to be **cautious** in determining mobility values from an SCLC analysis of current transients in SiOx devices.

- We hope this work is applied to other oxide devices exhibiting transients to **evaluate the validity** of an SCLC analysis in their own devices.

- In the future, these tools may help reveal alternative methods of determining **defect mobilities** in MIM devices. But more than this, they may help us explore the transient as a **tool** in characterising interfaces in a more general sense.