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# Impact of zirconium doping and lattice oxygen release on resistive switching characteristics of metal-oxide-semiconductor devices based on sputtered $Zr_xHf_{1–x}O_2$ gate dielectric

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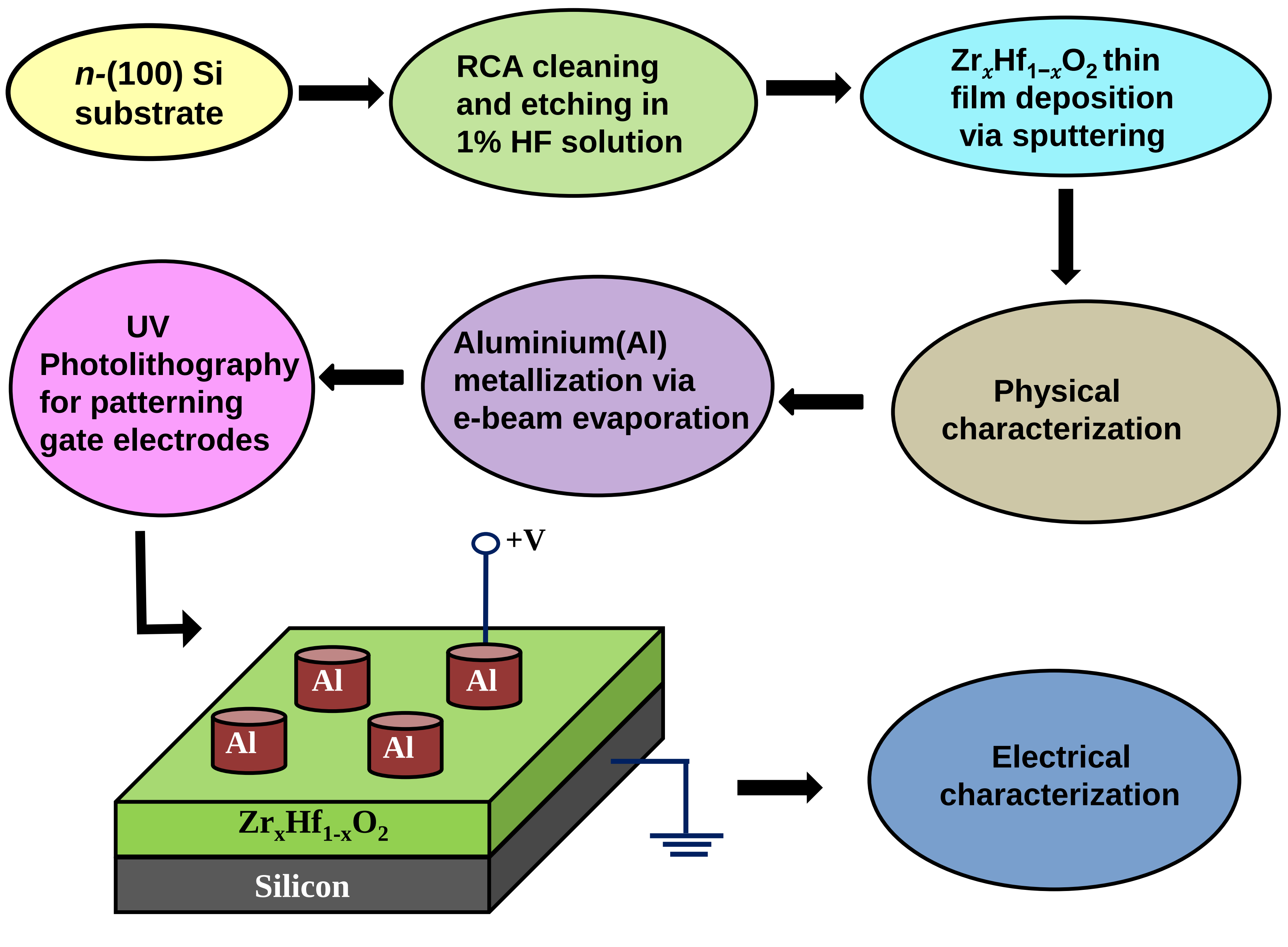
## INTRODUCTION & AIM

- Resistive random access memory (RRAM) devices are crucial in nonvolatile memory applications due to their simplicity in device fabrication, high switching speed, and low power consumption.
- RRAM devices consist of an insulator embedded between two electrodes.
- Recent studies revealed the switching nature of $ZrO_2$, $HfO_2$, $SiO_2$, $TiO_2$ for applications in RRAM devices.
- Among those oxides, research on $HfO_2$-based thin-films has been going on to improve the resistive switching performance of the devices.
- The oxide-based devices often show poor memory performance.
- $HfO_2$ doped with Zr shows improved device performances.
- The main aim of this work is to optimize the doping concentration for the best device performance.

## METHOD



**n-(100) Si substrate** → **RCA cleaning and etching in 1% HF solution** → **$Zr_xHf_{1–x}O_2$ thin film deposition via sputtering** → **Physical characterization** → **Aluminium(Al) metallization via e-beam evaporation** → **UV Photolithography for patterning gate electrodes** → **Electrical characterization**

**Figure 1**. Flow chart of the work

Pristine $HfO_2$ film deposited at 50 W, denoted as S1. The $Zr_xHf_{1–x}O_2$ films deposited at 1, 3, 5 and 7 of Zr power are respectively denoted as S2, S3, S4 and S5 . The concentration of Zr in S2, S3 and S4 are 8, 9 and 11%.

## RESULTS & DISCUSSION

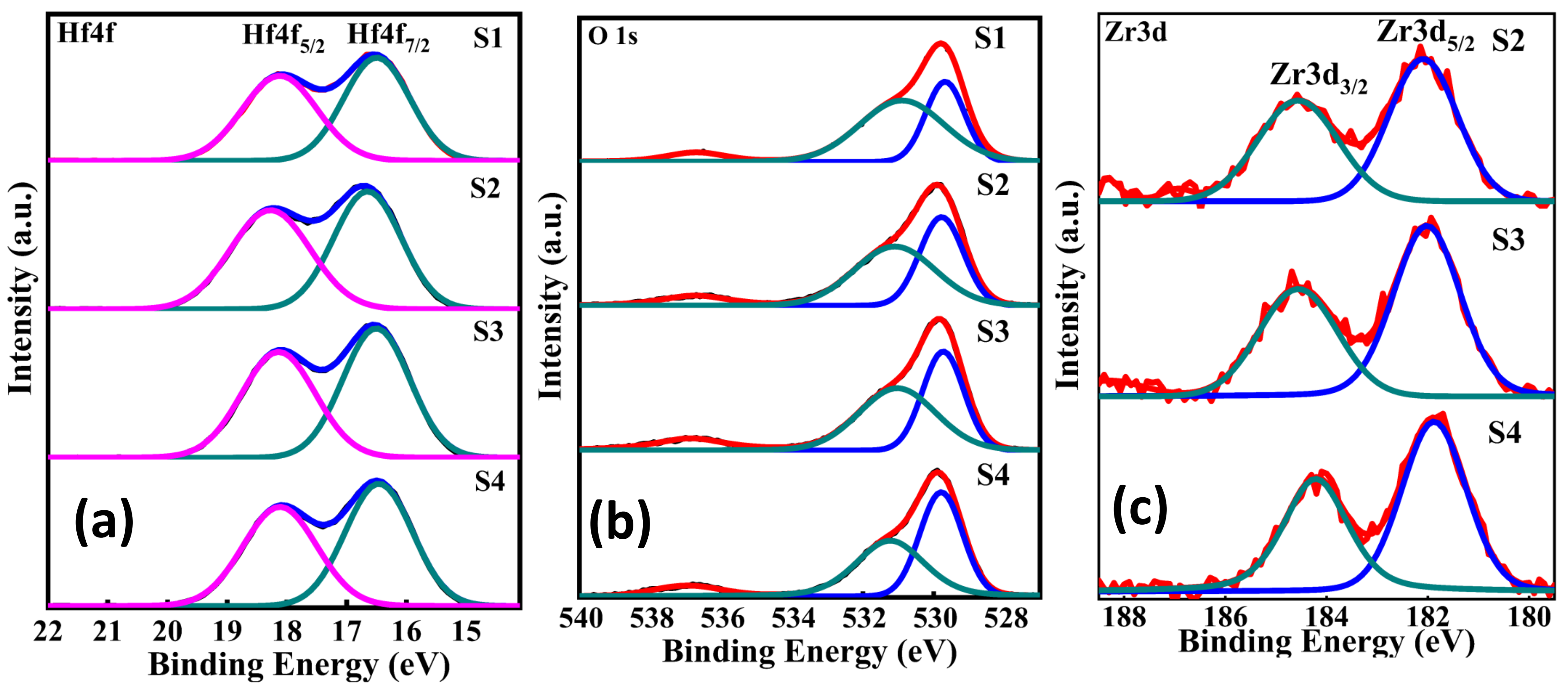


**Figure 2.** XPS spectra of (a) Hf 4f (b) O 1 s and (c) Zr 3d of the samples.

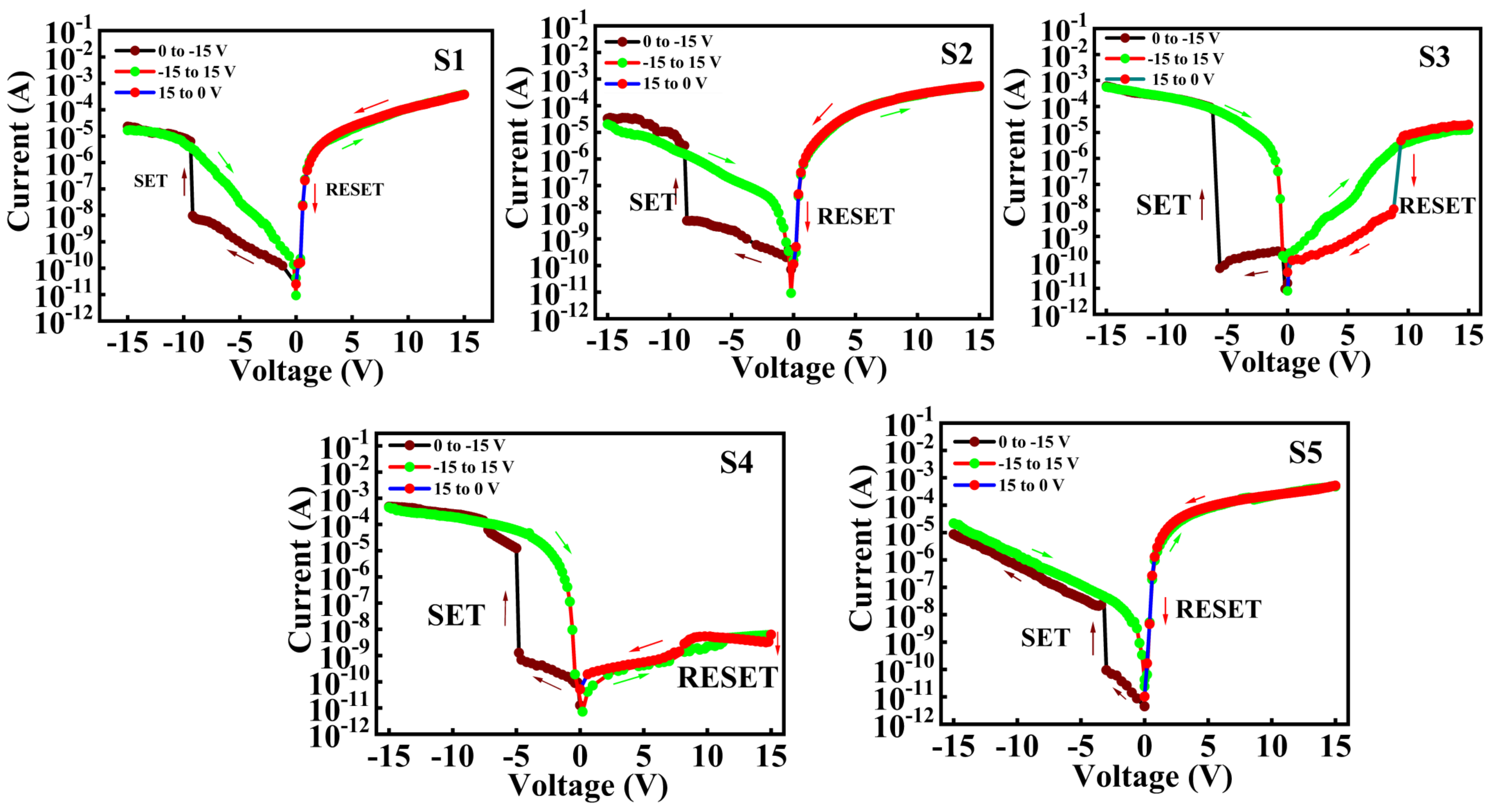


**Figure 3.** Current−Voltage (I-V)characteristics of the devices

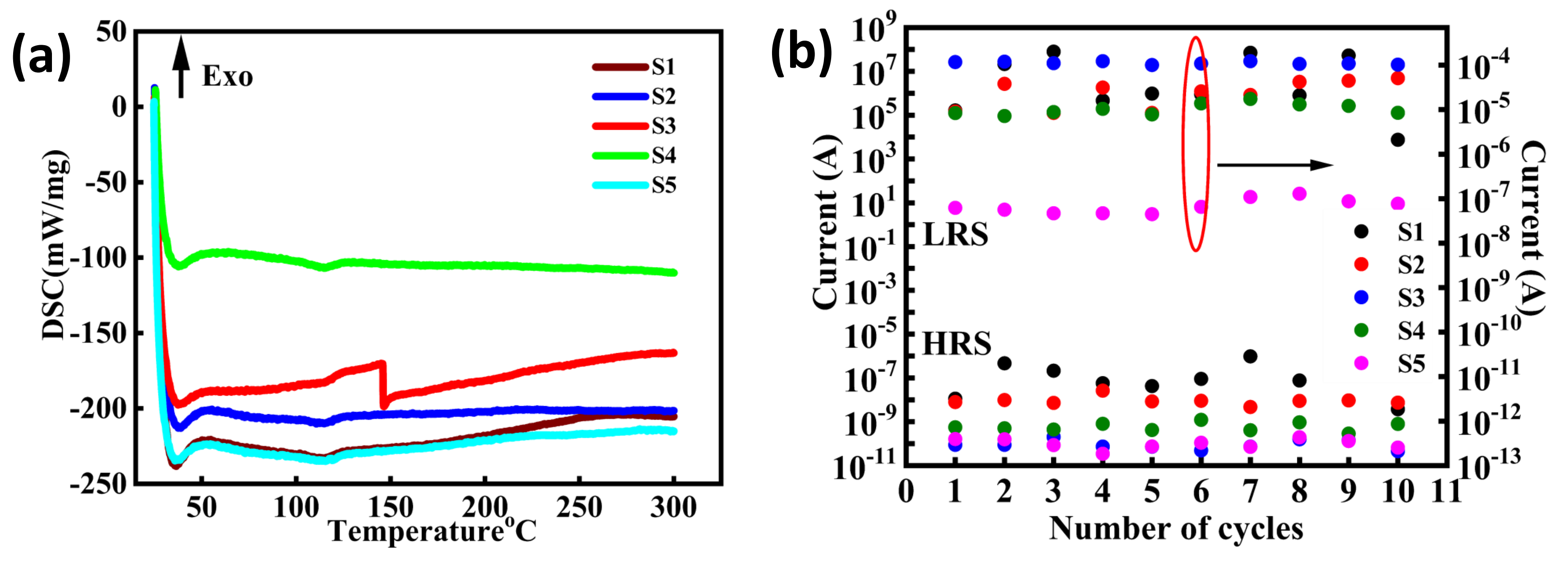


**Figure 4. (a)** Differential scanning calorimetry(DSC) measurement of all samples and (b) Current versus number of cycles at the HRS and LRS of the devices

## CONCLUSION

- The I − V characteristics of the MOS device show that the resistive switching property performs its best when the Zr content in the film is ~ 9 % .
- DSC study reveals release of lattice oxygen is responsible for creation of traps and attainment of best low resistive state.
- With increasing doping concentration, fluctuations in current at low resistance state and high resistance state of the devices are improved.

## REFERENCES

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