Research Center for Electronic and Optical Materials Seminar

Quantifying the oxygen vacancies and charge injection in ferroelectric hafnia-based devices

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Venue **The Large Seminar Room, 4F, Collaborative research building, Namiki-site**

Ferroelectricity in hafnia-based materials was first reported by Böscke et al in 2011 [Appl. Phys. Lett. 99, 102903 (2011)], opening the way to their integration in non-volatile memory and logic, fully compatible with current silicon technologies. In particular, $Hf_xZr_{1-x}O_2$, has attracted much attention thanks to the low recrystallization temperature and wide range of phase stability.

Several flavours of ferroelectric hafnia-based devices, notably in ferroelectric random access memories (FeRAMs) and ferroelectric field effect transistors (FeFETs), suitable for back and front end of the line silicon technologies, respectively. Amongst all emerging non-volatile memory technologies, ferroelectric based hafnia offers by far the lowest power rating, in addition to being extremely low cost and suitable for aggressive scaling.

The key performance parameters are the remanent polarization, the imprint or shift of the hysteresis loop along the voltage axis, the endurance in terms of operational cycles and retention. In this respect charged defects, specifically oxygen vacancies, and charge injection play a crucial role. Characterizing accurately the oxygen vacancy distribution in these sub 10 nm films, and their evolution with field cycling simulating operational use is therefore critical to industry.

Using customized device geometries, we have used HAXPES to characterize a wide range of HZO based devices, both capacitor and transistor stacks, with a view to implementation as FeRAMs and FeFETs.

The effect of processing conditions, interface chemical engineering and field cycling on the oxygen vacancy concentration profiles has been quantified allowing a broad coherent picture of the defect chemistry in these stacks to emerge.

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