DRC Short Course - Best Practices for Reporting on Electronic Devices – Sunday, June 21, 2026

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"Reliability Benchmark of Semiconducting Oxides Based Thin-Film Transistors: What to Measure and How to Determine Device Lifetime"

Adrian Chasin is a Principal Member of Technical Staff (PMTS) and the R&D team leader of the FEOL Reliability team at imec. He is involved in several logic/memory projects ranging from advanced devices architectures through new memory concepts to use of non-conventional semiconducting materials. He received the PhD in Electrical Engineering from the University of Leuven in 2014, when he developed devices based on new semiconducting oxides for display and flexible electronics targeting RF applications. After working at NXP on modelling/evaluation of CMOS technologies, he joined the imec reliability group in 2015 as a researcher. His main research interests are FEOL/MOL reliability in advanced CMOS technologies and thin-film devices for memory and BEOL applications. He authored and co-authored more than 200 publications.

Abstract:

Since the seminal work of Nomura [1], amorphous semiconducting oxide (AOS)–based thin-film transistors (TFTs) have enabled a wide range of applications, including display technologies [2], flexible electronics [3], ubiquitous RFID tags [4], and more recently non-volatile DRAM concepts [5]. These applications are driven by the unique properties of AOS materials, such as low-temperature processing (enabling flexible electronics and BEOL compatibility), high deposition uniformity (ensuring electrical uniformity over large-area backplanes), and low off-currents (supporting long retention times in DRAM cells).

Despite these advantages, device reliability—arguably the decisive parameter for large-scale adoption—has received comparatively limited attention. Reliability assessment in semiconducting oxides remains challenging due to intrinsic material complexity and the lack of standardized benchmarking practices. In particular, the absence of consensus on measurement methodologies and key figures of merit makes it difficult to compare results across studies and technologies.

This tutorial introduces a comprehensive methodology for evaluating and benchmarking the reliability of semiconducting oxide-based TFTs. Focusing on indium gallium zinc oxide (IGZO), the archetypal AOS material, we examine reliability across different material compositions and device architectures with emphasis on DRAM applications. We first explain why conventional positive bias temperature instability (PBTI) benchmarks developed for inversion-mode bulk silicon devices are not directly applicable to accumulation-mode IGZO TFTs, highlighting the importance of accurate electrostatic modelling. We then present a practical BTI characterization framework, including lifetime targets, degradation metrics, and key reliability figures of merit. Finally, the tutorial demonstrates how the proposed benchmark enables identification of current reliability gaps in IGZO TFTs for DRAM applications and discusses process strategies to mitigate these limitations.

The presented framework aims to provide researchers and engineers with practical guidelines for reliable characterization and meaningful comparison of emerging semiconducting oxide-based technologies.

[1] K. Nomura et al., Nature, vol.423, p.488, 2004; [2] T. Kamiya et al., Sci.Technol. Adv. Mater. vol.11, p.044305, 2010; [3] K. Myny, Nature Electronics, vol.1, p.30, 2018; [4] A. Chasin et al., IEEE T-ED, vol. 61, p.3289, 2014 ; [5] A. Belmonte et al., in Proc. IEDM, p.609, 2020

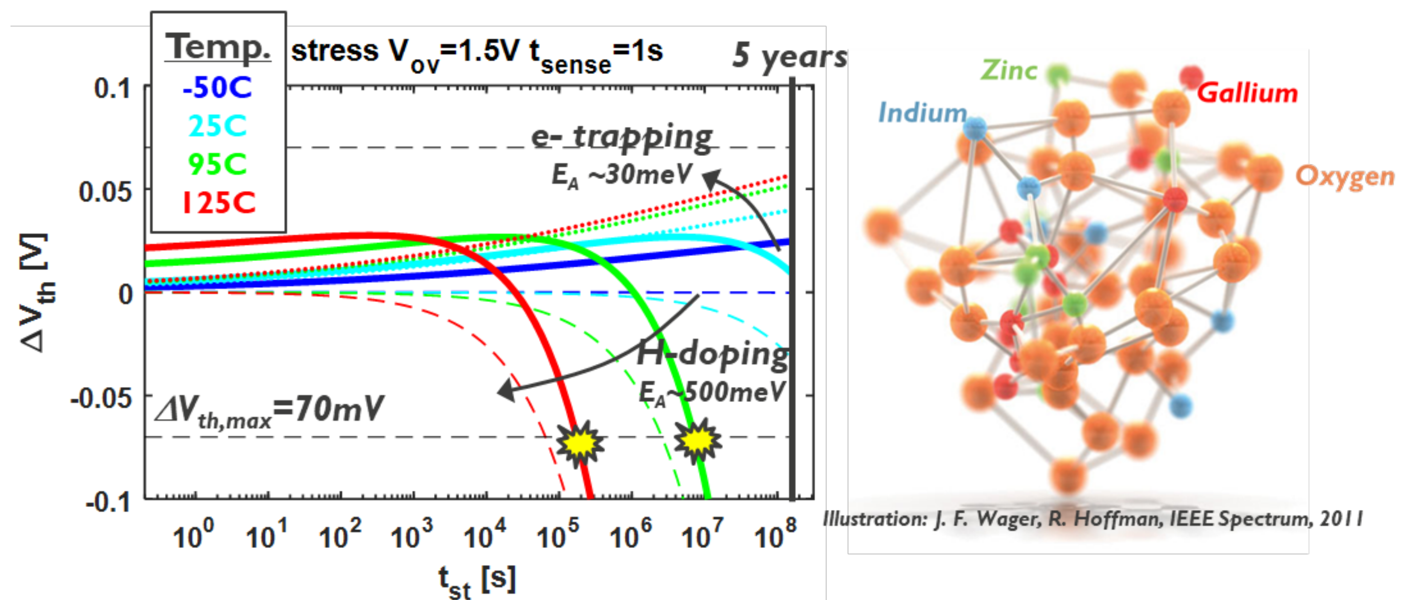

Illustration: J. F. Wager, R. Hoffman, IEEE Spectrum, 2011