

# Reliability of Poly-Si and IGZO TFTs

A tutorial presented by:

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## Abstract:

Low-temperature processed polycrystalline-silicon (LTPS) TFTs are currently the only technology that can produce high-resolution active-matrix liquid-crystal displays (AM-LCDs) and AM-organic light-emitting diode (OLED) displays as it can provide much higher mobilities than those of amorphous-Si. In the future, poly-Si is expected to realize high-density three-dimensional NAND flash memory. On the other hand, TFTs with amorphous  $\text{InGaZnO}_4$  (IGZO) and the variants (e.g., ZnO, IZO) have recently attracted a lot of attention for use in flexible and transparent displays. This is because of the possibility of low-temperature deposition (less than 150 °C) and the reasonably high electron mobility (around  $10 \text{ cm}^2/\text{Vs}$ ). For realization of those future applications, improvement of the mobility and reliability of TFTs are very important.

This tutorial will provide a reliability overview of both LTPS and IGZO TFTs. First, degradations of LTPS TFTs on transistor properties (mobility,  $V_{th}$  and  $S$ ) under various static and dynamic operations will be reviewed. It will be explained in terms of interface defect generation, self-heating and traps at grain-boundaries. Uniformity of the properties will be discussed as well with its relation to the microstructure of the poly-Si. Then, reliability of IGZO TFTs will be reviewed, after introducing fabrication process and transistor operation principles of the TFTs. Shift in  $V_{th}$  and degradation of  $S$  with bias stress will be discussed in conjunction with dependence on post thermal annealing and UV light exposure stress. It will be explained in terms of photo-generation of charges, charge trapping in the gate dielectric and/or at the channel/dielectric interface and trap state creation in the IGZO layer.

## Author Biography:

Ryoichi Ishihara received the B.E., M. E., and Ph. D. degrees from the Department of Physical Electronics, Tokyo Institute of Technology, Japan in 1991, 1993, and 1996, respectively. Since 1996, he has been with the [Delft Institute of Microsystems and Nanoelectronics \(DIMES\)](#), Delft University of Technology, Delft, The Netherlands, where he is currently an Associate Professor. His research has been focused on 3D-ICs and flexible electronics based on TFTs fabricated in a single-grain, so called "single-grain TFTs". He has developed novel excimer-laser crystallization processes enabling location and orientation control of grains of silicon and germanium. He has also been studying fabrication of transparent oxide semiconductors and carbon nano tubes. He has been in charge of a number of national and European projects related to 3D-ICs and flexible electronics. He is a co-author of more than 60 journal papers and 90 international conference papers and a co-inventor of ten granted patent families. He has given 15 invited lectures at various international conferences on display and VLSI technologies.