Material and Device Innovation for AIoT and Automotive Applications

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There is an undisputed consensus: Internet of Thing (IoT) will have an enormous economic impact and is a big driver for the growth of the semiconductor market after the smartphone. Sensors, microcontrollers, microprocessors, embedded non-volatile memory (eNVM) and analog/RF technologies will be the key drivers for IoT. At the core of it: IoT is about having electronic devices connected to the Internet, capable of identifying themselves and communicating data to other devices on the network.

The connected car has been a familiar example of IoT technology, making the automotive industry an enormous driver for IoT growth in the next 5 years. Cars rely on greater intelligence, connectivity and sophisticated electronics as illustrated in Figure 1a (1). Today, consumers demand cars that sync with smartphones and in-vehicle infotainment capability; and governments mandate improvement in safety and fuel efficiency. Over the next decades, it is predicted that more than 100 million cars worldwide will have autonomous-driving features and simultaneous connectivity, both vehicle-to-vehicle and vehicle-to-infrastructure. This will continue to drive the automotive electronic content to beyond 30% of the total vehicle bill of material (2).

To address the requirements of this strong emerging industry trend, electronic content must have; high degrees of functional integration and superior reliability in harsh environment (automotive); all while maintaining excellent power/performance and cost benefits. In this talk, we will discuss FDSOI, as shown in Figure 1b, as a candidate technology for enabling future automotive and IOT applications based on providing minimum energy consumption, better performance and RF/analog co-integration capabilities with the least process and design disruption for low cost and fast time to market. FDSOI on ultra-thin box enables a wide range of back bias which can be used to further reduce power consumption without adding process complexity for multi-threshold voltage option as used in bulk devices (Figure 1c, (3)). The forward bias can also be used to provide a higher drive current for operating stacked embedded emerging memory such as MRAM.

Automotive electronics require much more stringent reliability requirements compared to consumer electronics. Ultra-thin body FDSOI devices are totally isolated with the buried oxide, which tremendously improves the soft error rate, as shown in Figure 1d (4), and thus enhances the reliability and reduces the need for error correction and redundancy with scaling. Furthermore, FDSOI devices allows operating at a wide temperature range (-40C to 150C), unattainable by bulk devices especially at high temperatures due to extremely low junction leakage current.

References:
1. Clemson University Vehicular Electronics Lab, http://www.cvel.clemson.edu/auto/systems/auto-systems.html
2. Globalfoundries, "FD-SOI Technology Innovations Extend Moore's Law" white paper, Sept. 2015, http://globalfoundries.com
3. Q. Liu et al, IEEE IEDM 2013
4. P. Roche et al, IEEE IEDM 2013

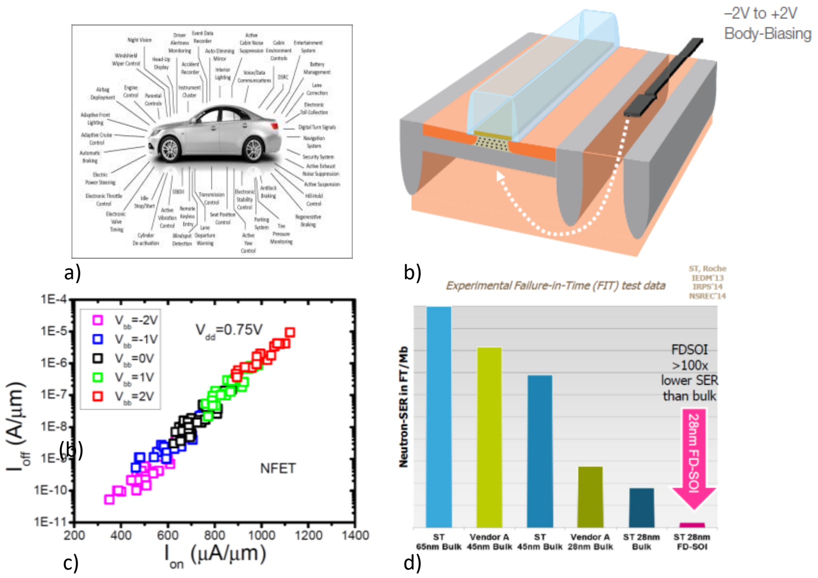

Figure 1: a) electronic parts for typical vehicle [source: Clemson University Vehicular Electronics Lab]; b) FD-SOI device with Back Bias [Globalfoundries, "FD-SOI Technology Innovations Extend Moore's Law" white paper, September 2015, http://globalfoundries.com/]; c) Ion

vs. Ioff with back-bias up to +/-2V [Q. Liu et al, IEEE IEDM 2013]; d) Experimental SER comparison across technology [P. Roche et al, IEEE IEDM 2013]