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CMOS technology underpins most of the IC market today because it offers high speed, high density and cost-effective solutions for many of the electronic goods and equipment on the market. Silicon remains the prime semiconductor of choice for this technology. As the capabilities have increased in the computing power of a chip – or alternatively, the chip sizes have shrunk to support a given functionality, extensions to the capabilities have been sought particularly to increase sensor functions and bring these on chip. One area of growth over the last decade especially has been in optoelectronics, and in this area silicon is an excellent material for detecting light. The most common application of silicon has been in cameras either as stand-alone (digital camera) or incorporated into mobile phones. However, there are also wide applications in the industry for photodiodes for signal processing applications. Silicon is able to respond to light from longer wavelength U.V. to near infra-red which conveniently includes the visible spectrum.

In the imaging market, pixel-based sensors (CMOS image sensors, C.I.S.) have been developed by many companies in conjunction with digital processing chips to handle a wide variety of applications from small arrays such as VGA to sensors as large as a single wafer for medical applications. Pixels can be as simple as the basic 3 transistor cell but may include additional transistors. Generally speaking, the dynamic range of the sensor is controlled at one end by the maximum amount of light a pixel can receive, and at the other by the leakage current of the photodiode in the dark, called dark current. As geometries reduce, pixels have migrated from simple diodes to pinned photodiodes to reduce leakage currents, but such techniques have enabled CMOS image sensors to match the performance of CCD technology, which has been the benchmark. XFAB has demonstrated dark currents which are excellent. Low dark currents are also important for solar photovoltaics where electricity generation can be maximised for lower light levels.

Photodiodes on the other hand have been optimised for given wavelengths and speed. The sensitivity of a photodiode is determined by how much light can be converted into electron-hole pairs, and using an anti-reflective coating enables quantum efficiencies of over 90% of theoretical to be achieved. XFAB’s latest photodiodes have demonstrated over 0.3A/W for blue light (405 nm) while also responding to N.I.R. to 850 nm. These are used in applications such as hand-held communication devices and CD/DVD players.

The market for optoelectronics is expected to expand as applications such as video on demand become available from the broadband network - indeed the 1990’s “dotcom” bubble was perhaps a decade earlier than the market was ready for but will eventually occur; the use

of LED lighting has increasingly required silicon to monitor, control and provide drive functionality; cameras are expected to be used increasingly in cars for parking mirror, side view mirror and vision assistance applications; time of flight cells still have to make a large impression in the market but offer the potential for distance measurement which is useful for car safety; and 3D camera applications. All of this will increase the uptake of silicon and it is quite clear that there are still decades of life in this technology yet.
John Ellis has worked in the semiconductor industry for over thirty years. He has been responsible for developing new CMOS processes and devices, which range from larger than 1.5 micron many years ago to 0.18 micron devices today. He has developed EEPROM cells, and has lead a BiCMOS development. Extensive use of TCAD has been made, but in addition, he has also written 2D and 3D device models to study thermal and electrical performance of new devices. He currently leads a team in X-FAB, Plymouth, which is responsible for developing, among other things, high voltage transistors on the company's 0.35 micron CMOS process, recently adding 100V LDMOS devices to the technology. These have applications in LED drivers as well as other power control applications.

John takes a keen interest in training engineers and has prepared and presented a Semiconductor course which is practically based as far as possible. This included writing a simple model of a silicon lattice which can be shown tilted and rotated to present different aspects from the surface, which relates to ion implantation. He has demonstrated how numerical device models work with simple Excel spreadsheet calculations, to show how basic principles can be explained using familiar tools.

John has extensive experience in optoelectronic applications and has steered a cross-site team to a successful demonstration of a high sensitivity PIN photodiode technology, and worked leading X-FAB's Opto team to improve dark currents in a 0.18 micron process for pixel applications. He is currently a Senior Member of the Technical Staff and has overall responsibility for the technical aspects of opto development in X-FAB.

John holds BSc and PhD degrees from the University of Kent, Canterbury, and has developed or co-developed several patents ranging from RF applications for CMOS to novel devices, one of which relates to surround-gate type CMOS which is currently under intense interest for nanoscale applications.