ziehm imaging

Advanced flat-panel detector technology

A comparison of IGZO and amorphous silicon (a-Si)

Ziehm Imaging has taken the next step in the evolution of flat-panel detectors with the introduction of indium gallium zinc oxide (IGZO) technology.

As image intensifiers have largely fallen from favor, flat-panel technology is being used worldwide. While amorphous silicon detectors drove that paradigm shift in the beginning, far more advanced types of detectors are being employed today.

The introduction of complementary metal-oxide-semiconductor (CMOS) technology presents a premium option to significantly enhance image quality, though at the expense of higher production complexity and cost.

With the recent integration of IGZO detectors into C-arms, the market is now able to reap the advantage of an innovation that combines high-performance imaging with a much more cost-effective approach.

Flat-panel detectors as the industry standard

Flat-panel detectors (FDs) have been the standard in mobile and fixed X-ray imaging for many years. They were preferred to image intensifiers (I.I.) as they ensure superior image quality at lower detector dose levels, in addition to a more compact design. The absence of geometric distortion, extended dynamic range, and dose-efficient operation makes them indispensable in today's X-ray devices, particularly for minimally invasive procedures where accuracy and dose optimization are of the utmost importance.

The emergence of IGZO technologies

The foundation of most flat-panel detectors over the past two decades has been amorphous silicon (a-Si) arrays. As a-Si technology quickly matured, it provided a stable, cost-effective and reliable platform, especially for larger detectors. Its proven clinical performance made it the workhorse of most X-ray imaging systems. More recently, however, there has been the development of indium gallium zinc oxide (IGZO) detectors, which feature a novel semiconductor that addresses several limitations of a-Si ones. IGZO technology offers significantly higher electron mobility and lower noise, allowing for significantly improved resolution, higher image quality and increased frame rates in fluoroscopy.

The technology behind IGZO

IGZO detectors use oxide semiconductors with a higher electron mobility compared to the amorphous silicon structure. This allows for improved resolution, which translates into a more detailed visualization of small anatomical structures. Finally, IGZO detectors provide higher frame rates, which are necessary for dynamic procedures and real-time guidance.

Advantages of IGZO over a-Si

Higher electron mobility
→ up to 50 x faster than a-Si, reducing noise
Higher resolution due to smaller pixel size
→ clear visualization of small details
Support for high frame rates
→ enabling smooth fluoroscopy and interventional imaging

The advantages of IGZO detectors, such as higher electron mobility, lower noise and improved frame rates, along with their higher resolution make them a viable replacement for a-Si in mobile fluoroscopy and interventional imaging.

Positioning of detector technologies today

- **Amorphous silicon (a-Si)**
  Mature, reliable, cost-efficient, clinically proven but limited performance regarding spatial resolution and dose efficiency.
- **Indium gallium zinc oxide (IGZO)**
  Advanced oxide semiconductor with high electron mobility, spatial resolution, and dose efficiency.
- **Complementary metal-oxide-semiconductor (CMOS)**
  Crystalline silicon with the highest resolution and lowest noise for high-end applications. Ziehm Imaging's CMOSline[1] features a small pixel size of just 100 µm, supporting excellent image quality.

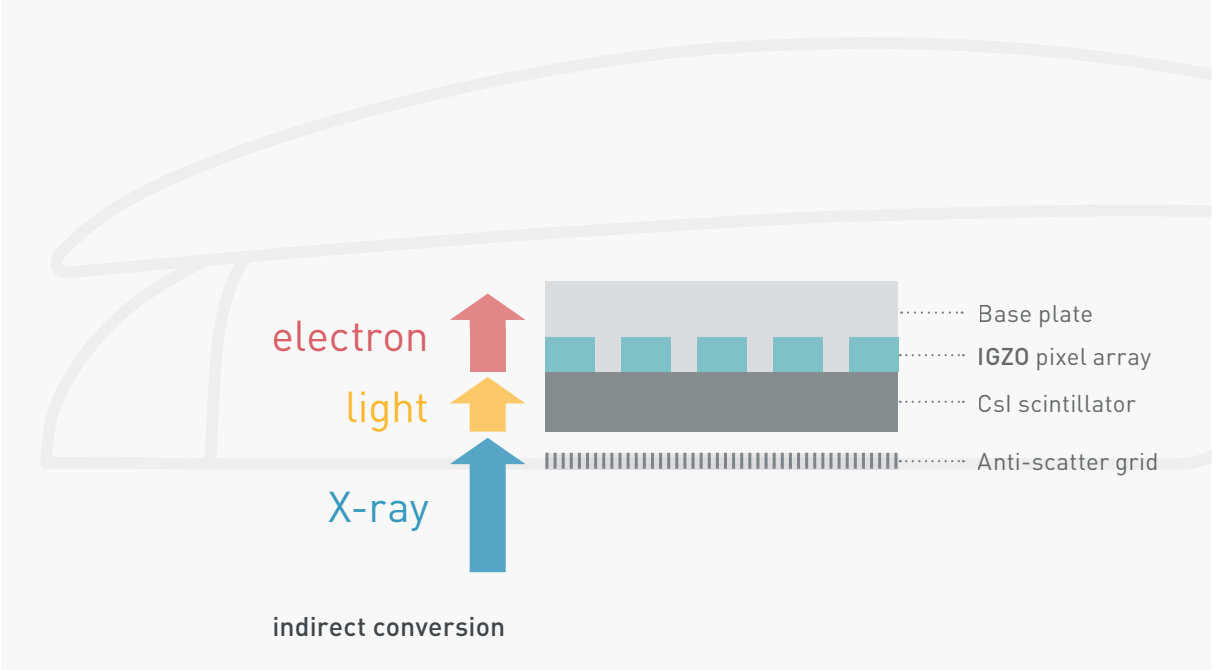

Figure 1: Working principle of X-ray conversion in an IGZO detector

Table 1: Comparison of different flat-panel detectors of Ziehm Imaging

a-Si	IGZO	CMOS
Advantages: – Cost-effective in large formats compared to image intensifiers **Limitations:** – Limited spatial resolution – Limited low-dose performance due to read noise and slower readout	**Advantages:** – Increased electron mobility – Increased spatial resolution – Faster readout speed **Limitations:** – Lower resolution, speed and low-dose performance than CMOS	**Advantages:** – Excellent low-dose performance – Highest spatial resolution – Highest readout speed – 100 µm pixel size **Limitations:** – Higher manufacturing cost (premium price point)
Mature, cost-effective **entry-level** technology	Balanced **price-performance** technology	**High-end** premium-performance technology

Conclusion

IGZO has become the new benchmark for advanced, cost-efficient C-arm detectors, offering higher electron mobility, optimized noise and dose efficiency and a superior spatial resolution compared to a-Si technology.

IGZO bridges the gap between conventional flat-panel solutions and premium CMOS detectors, setting the standard for imaging in various clinical applications like interventional radiology and fluoroscopy.

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[1] The CMOSline is a system configuration based on the Ziehm Imaging CMOS flat-panel detector.