The gradual migration to cameras using CMOS sensors in a market more familiar with CCDs.

- **Andrew Kirby, Technical Specialist, Atik Cameras**

For over 23 years, Atik Cameras has been at the forefront of innovation, consistently delivering top-tier low-light cameras renowned for their unparalleled sensitivity and minimal noise, catering to the exacting demands of scientific exploration, sky surveillance, and the captivating world of astrophotography.

Like several other companies, we originally concentrated on producing products based around CCD sensors. However, technology has progressed, and we are now able to offer a wide range of cutting-edge cameras based on CMOS sensors. This article briefly discusses what brought about this change and what new product solutions we can provide.

CMOS sensors have gradually displaced CCDs, even in the performance sector of the market such as low-light imaging. Early CMOS sensors were once considered CCDs poor relation. They were relatively noisy and exhibited low dynamic range, which made them unsuitable for high-performance applications. However, these CMOS sensors could offer much higher frame rates compared to CCDs because they use a parallel readout architecture rather than serial. This made them preferable for all manner of domestic applications where the ability to capture video was important. By contrast, CCDs have traditionally been limited to imaging static or slow-moving objects. Additionally, if you wanted a sensor with a very large number of pixels then it would not be attractive to choose CCD because of the lengthy time to download the image. However, **in recent years a great deal of progress has been made, led in particular by the rapid evolution of mobile phones**. This technology has transferred into other products such as DSLRs. Once you have several markets all demanding components based on related technologies then production costs benefit from the economies of scale. As manufacturers were devoting more resources to CMOS it no longer made commercial sense to continue to develop CCDs sensors. Moving forward to the present, **CMOS sensors have improved to such an extent that for nearly all applications they are as good or better than CCDs**. Performance has improved, frame rates are higher and the number of pixels that can be accommodated into the device is ever-increasing. **We now have one technology that can almost do it all**.

As fabrication plants have reorganised to manufacture performance CMOS sensors, we are inevitably approaching the time when CCD imaging sensors will no longer be available to purchase in quantity. **The market focus has shifted**.

As one example, **Sony issued a last option to buy in late September 2024**. Consequently, camera manufacturers have been forced to redesign their products for these newer CMOS sensors. This process has created a significant challenge since the technologies and the ways that they are incorporated differ substantially from what has gone before - they are not simply like-for-like replacements. Consequently, there has been a period of transition as the industry has learned to adapt. **In anticipation of this, Atik Cameras adopted a proactive approach some time ago and started to develop CMOS designs in parallel with our existing CCD cameras**. In fact, we released our first high-performance CMOS camera, the Horizon (Fig 1.), back in **2017**.

Fig 1. The first-generation Atik Horizon CMOS camera released in 2017

We have accumulated a vast knowledgebase through continual experimentation and development which has benefited our subsequent camera designs. Therefore, **in contrast to many of our competitors, we have gained an advantage by becoming an early adopter of CMOS**. We are comfortable with the technology and our products are more mature.

In addition, it has been necessary to educate customers about the benefits of migrating to cameras equipped with CMOS sensors, along with key differences in the way that they can be operated. For example, a completely new concept for many is the ability to reduce read noise even further by sacrificing some of the pixel well depth simply by selecting an option in the software. Another is the dark current, once seen as a critical metric of CCD performance where it was essential to cool the device. By comparison, **current CMOS sensors do not need to be deep cooled to such a degree in order to minimise the dark current**. In fact, the dark current is now so small that it is becoming more difficult to measure! In the future, many customers will probably no longer be concerned with dark current levels for their applications, as they will be accepted as not being a limitation.

Whether you are using a CMOS camera in a standalone application, or are integrating it into a complex scientific instrument, **it is important to be aware of how both the hardware and software environment have changed**. The way of working has changed for the better. Product performance has improved and increased flexibility, particularly through software control, is advantageous.

Atik can offer a range of cameras based on high-performance CMOS sensors. Our highly flexible product design process means we can tailor bespoke products to your requirements in shorter times. For example, we can repackage off-the-shelf models, such as our APX range (Fig 2.), into a form factor that allows easy integration into your system.

Fig 2. Atik APX60 large format CMOS camera

We were also the **first manufacturer to create an entire high-performance CMOS camera from scratch for an OEM** with an application requiring very long exposures.

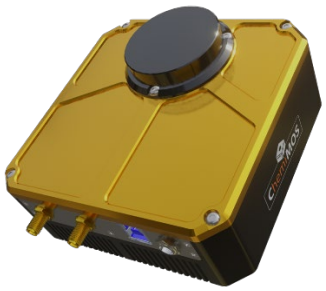

Fig 3. Atik ChemiMOS OEM CMOS camera

Options such as external triggers can be added and cameras with smaller sensors can be specified with C-mount adaptors.

We can also offer cameras based on windowless CMOS sensors which is unusual in the industry. This can be **useful for customers who are worried about some of the signal being lost, particularly in the UV or near IR regions**. Removing the sensor window can also be beneficial in applications using lasers where interference is a problem. Another example is where optical components such as fibre light guides need to be mounted in close proximity to the surface of the sensor.

Glossary:

CCD: Charge Coupled Device – an image sensor technology formed from an array of capacitive elements.

CMOS: Complementary Metal Oxide Semiconductor – a type of fabrication technology used in image sensors and many other electronic devices, such as the transistors within microprocessors and memory modules. Images can be downloaded rapidly since the data is read out in parallel.

Dark Current: A measure of the number of thermally generated electrons per pixel, shown as e^-/p/s. It is temperature dependant. i.e. dark current falls with decreasing temperature. Sensors with high dark currents are unsuitable for long exposure applications.

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