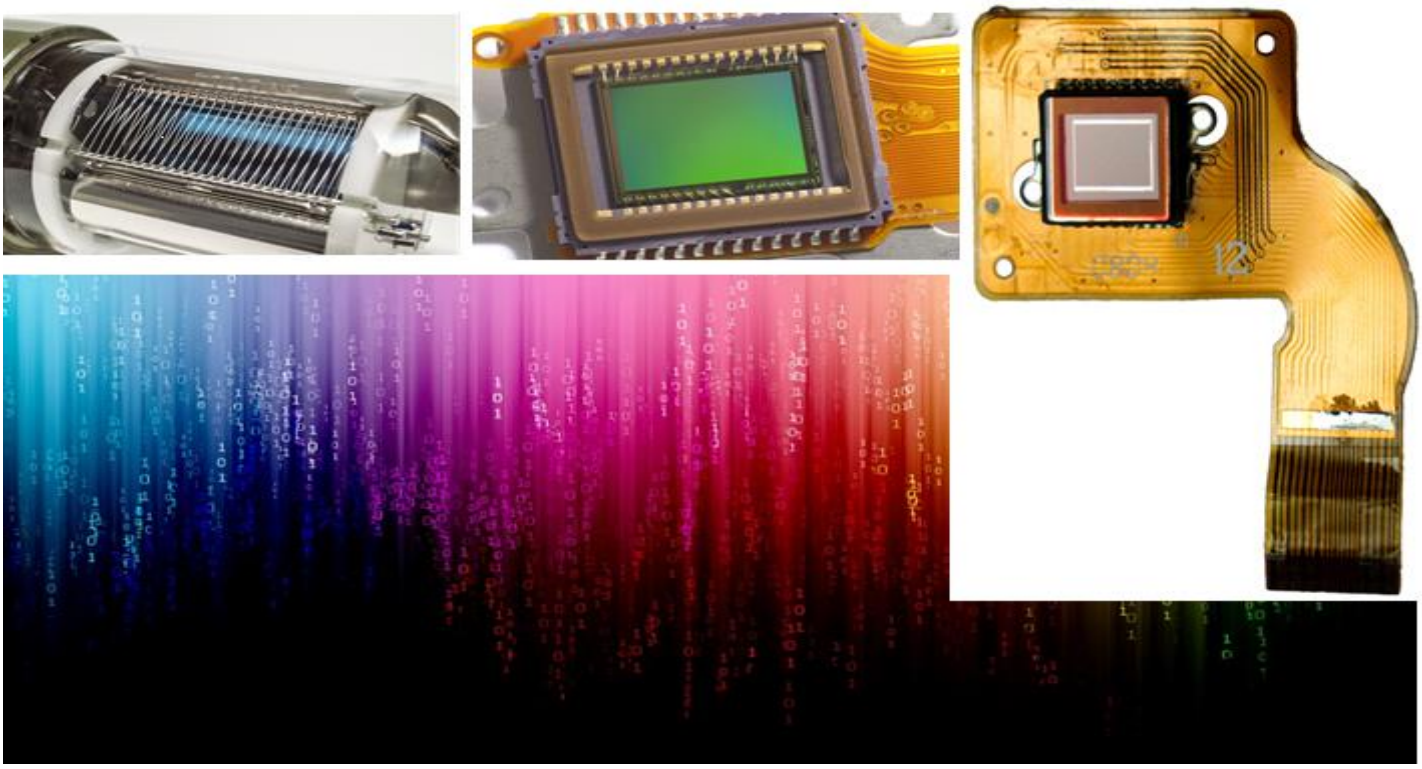
OES Technology



FROM PMT to CCD and CMOS

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August 2020
www.aruntechnology.com

Introduction

Large foundries and primary producers of steel, aluminium, or copper, as well as many secondary metal processors, aerospace and automotive companies, testing laboratories, governmental and academic labs are just few places in need to test materials. These users must identify and measure, with especially high accuracy and precision all the elements and compounds in their incoming, production, and outgoing materials. Optical Emission Spectroscopy, or OES, is a reliable and extensively used analytical technique used to establish the elemental composition of a wide range of metals.

Photomultiplier Tube (PMT)

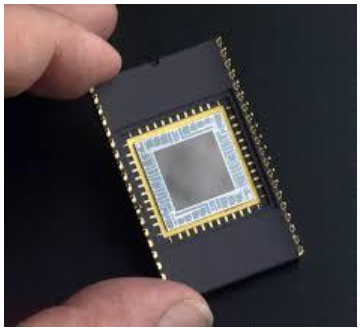
Since 1960, PMTs were used as standard detectors in the field of spark spectrometry due to their extremely high sensitivity in the ultra-violet (UV) region and the possibility of time-resolved measurements (TRM).

A PMT detector consists of an evacuated glass housing enclosing several light-detection elements. Light from a sample's arc spark excitation enters the tube and strikes a thin photocathode layer, which ejects electrons. These are focused, greatly amplified, and converted into electronic signals. A tube requires operating power of up to 1200 volts.

As analyser components, PMTs are considered relatively robust. Their ability to enable accurate identification and measurement of the elements for which they are configured has been proven over many years. In terms of performance, they are noted for high gain, low noise, and good speed of measurement. Their excellent trace element detection capability is aided by their markedly high dynamic range.

However, PMTs also suffer from significant drawbacks. PMTs are expensive. Each PMT-based analyser must be configured to detect only a relatively small number of elements in given matrices. Adding or subtracting another element necessitates major hardware alterations. Analytical lines from closely adjacent elements may cause interference. If a PMT detector fails, the analyser cannot see that element's wavelength, potentially degrading performance of the entire optical system.

Charge Coupled Device (CCD)



To overcome PMTs' disadvantages, many spectrometer manufacturers turned to detectors based on the charge coupled device (CCD).

Invented in 1969, CCDs were first used in camera and imaging sensors. A CCD is basically a solid-state integrated circuit (IC) that is etched onto a silicon substrate.

It contains a linear array of several thousand miniature light-sensitive elements (also known as pixels). Fundamentally, a CCD sensor captures light and converts it into an electrical charge. The more light captured, the greater the charge.

In 1989, Arun Technology was first to pioneer by developing, manufacturing and using CCD with OES spectrometers for metal analysis. In CCD-based spectrometers, each pixel's signal of the intensity of light at its location is fed to the spectrometer's readout electronics for processing.

For demanding tasks such as primary metal production, CCD-based systems have not been able to match the performance of PMT based analysers. This is especially true with regards to low detection limits. CCD sensors can detect the emitted visible spectrum from 400nm-1000nm simultaneously but usually require multiple integrations to pick up the information from the emission lines of interest.

Complementary Metal Oxide Semiconductor (CMOS)

A CMOS approach provides a good alternative to PMT´s and CCD´s, as it offers both time-resolved measurement capability (TRM) and spatial resolution. Like CCD-based models, complementary metal oxide semiconductor (CMOS) detectors are solid state devices manufactured with proven IC (integrated circuit) detector technology. CMOS detectors share basic CCD advantages over PMTs, such as quality consistency and reproducibility. Years of development have gone into making CMOS a new, distinctly different detector type that is a great improvement over CCD technology.

A CMOS detector is a multichannel semiconductor device wherein parts of the readout electronics, performing tasks such as analogue to digital conversion and noise reduction are integrated onto the sensor die during fabrication of each integrated circuit. This results in advantages such as greater dynamic range and higher data throughput.

CMOS transistors are known for their efficient use of electrical power. They require no electrical current except when they are changing from one state to another. Additionally, the complimentary semiconductors work together to limit the output voltage. The result is a low-power design that gives off minimal heat.