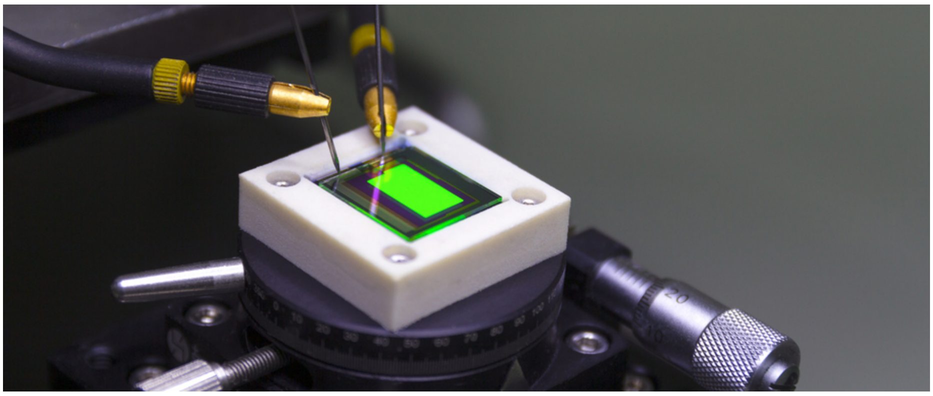
Tubeless Streak Pixel for Sub-Nanosecond Optical Imaging

TECHNOLOGY NUMBER: 6493



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Hardware
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Semiconductor, MEMS, and Electronics

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OVERVIEW

High-speed, real-time CMOS image sensors for time-resolved fluorescence lifetime imaging

- Significant increase in imaging speed and data processing efficiency
- Biomedical imaging, 3-D imaging, navigation, optical engineering

BACKGROUND

Time-resolved active imaging is a crucial technique in biomedical, scientific, and engineering applications, capturing transient optical signals for in-depth analysis. This includes 3-D imaging sensors using time-of-flight (TOF) and fluorescence lifetime imaging microscopy (FLIM) for cellular-level biological analysis, essential for navigation and precise medical procedures. Historically, methods like time-correlated single photon counting (TCSPC), time-gated imaging, and streak cameras have been employed. However, their practical application is hindered by limitations such as slow acquisition speeds and high costs, particularly in real-time scenarios where motion or repeated imaging is necessary. Existing methods often struggle with low photon detection rates and complex systems, ultimately reducing their efficiency and feasibility in practical settings. Consequently, there is a significant need for an improved, cost-effective, high-speed, and compact imaging system to make this technology widely accessible and practical.

INNOVATION

Researchers at the University of Michigan have developed high-speed CMOS time-resolved active image sensors designed for real-time fluorescence lifetime imaging, greatly enhancing photon acquisition rates and data handling efficiency. Unlike traditional rapid lifetime determination (RLD) with limited dynamic ranges, this method utilizes the center-of-mass method (CMM) algorithm, which offers a wide dynamic range and simple calculations. The approach involves pixel-level lifetime estimation and multi-shutter pixels for high photon economy, offering better signal-to-noise ratios critical for in vivo imaging. Innovations include the use of lateral electric fields for time-to-space conversion and mixed-signal data compression to reduce data rates, ensuring high-frame-rate operations.

ADDITIONAL INFORMATION

INTELLECTUAL PROPERTY

US20160356718A1 "Pixel circuit and method for optical sensing"