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# ENERGY-EFFICIENT NONLINEAR OPTICAL MICRO-DEVICE ARRAYS

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## **INVENTORS**

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## OTHER INFORMATION

#### **CATEGORIZED AS**

- » Optics and Photonics
  - » All Optics and Photonics
- » Imaging
  - » Other
- » Materials & Chemicals
  - >> Chemicals
  - » Other
- » Semiconductors
  - » Materials

**RELATED CASES** 

2025-015-0

## PATENT STATUS

Patent Pending

#### **BRIEF DESCRIPTION**

Optical neural networks (ONNs) are a promising computational alternative for deep learning due to their inherent massive parallelism for linear operations. However, the development of energy-efficient and highly parallel optical nonlinearities, a critical component in ONNs, remains an outstanding challenge.

To address this situation, researchers at UC Berkeley and Berkeley National Lab developed a nonlinear optical microdevice array (NOMA) compatible with incoherent illumination by integrating the liquid crystal cell with silicon photodiodes at the single-pixel level. The researchers fabricated NOMA with over half a million pixels, each functioning as an optical analog of the rectified linear unit at ultralow switching energy down to 100 femtojoules/pixel. The team demonstrated an optical multilayer neural network.

This work holds promise for large-scale and low-power deep ONNs, computer vision, and real-time optical image processing.

#### SUGGESTED USES

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Large-scale and low-power deep optical neural networks: The array's design is ideal for building expansive and energy-efficient neural networks that use light for computation.

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Computer vision: The NOMA can be applied in systems that require fast and efficient processing of visual data.

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Real-time optical image processing: The device's high-speed, parallel processing capabilities make it suitable for applications needing instantaneous image manipulation and analysis.

# **ADVANTAGES**

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Ultralow energy consumption: Each pixel operates at a remarkably low switching energy of 100 femtojoules, making the device highly energy-efficient.

**>>** 

High parallelism and scalability: The array contains over half a million pixels, enabling massive parallel operations, which is crucial for deep learning and other computationally intensive tasks.

**>>** 

Integration with incoherent light: The device's compatibility with incoherent illumination expands its usability and simplifies system design.

## **RELATED MATERIALS**

### ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Apparatus and Method for 2D-based Optoelectronic Imaging



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