

Article Overview

In a spectrometer, the encoder precisely monitors the position or rotation of optical components, such as diffraction gratings, to ensure accurate wavelength selection and high-resolution spectral measurements.

Role of the Encoder

An encoder in a spectrometer serves as a position-sensing device that converts the physical motion of moving components--typically the rotation of a diffraction grating or prism--into electrical signals that can be read by the spectrometer's control system . This allows the spectrometer to determine the exact angle or displacement of the optical element, which directly corresponds to the wavelength of light being measured .

How It Works

Encoders can be rotary or linear, depending on the type of motion they monitor. In optical spectrometers, rotary encoders are most common. They consist of a disc with optical or magnetic patterns and a sensor that detects transitions as the disc rotates . Each transition generates a digital signal representing a small increment of rotation, allowing the system to track angular position with high precision. Absolute encoders provide a unique digital code for each position, while incremental encoders count pulses to determine relative movement .

Importance in Spectrometry

The encoder ensures that the diffraction grating or prism is positioned accurately, which is critical for:

- o Wavelength accuracy: The exact angle of the grating determines which wavelength reaches the detector .
- o Spectral resolution: Fine control of grating rotation allows the spectrometer to resolve closely spaced spectral lines .
- o Repeatability: Encoders enable the spectrometer to return to previously measured wavelengths reliably, which is essential for calibration and comparative measurements . Without an encoder, the spectrometer would lack precise feedback on the optical component's position, leading to errors in wavelength assignment and reduced measurement reliability.

Summary

In essence, the encoder acts as a bridge between the mechanical motion of optical elements and the digital control system of the spectrometer. By providing accurate, real-time position feedback, it ensures that the spectrometer can select, measure, and reproduce specific wavelengths with high precision, which is fundamental for reliable spectral analysis .

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In this work, inspired by the biological encoders, we introduce a generic spectral encoder that bridges this gap, transforming a

Raman spectroscopy represents an advanced process analytical technology to monitor and control chemical and

Computational spectrometers are pivotal in enabling low-cost, in-situ and rapid spectral analysis, with potential

However, expensive spectral encoders and unstable algorithms impede widespread applications of the computational spectrometers.

The emergence of reconstructive spectrometers represents a transformative leap in spectral analysis, combining

Stress-engineered plastic elements enable cost-effective, portable spectrometers that cover both the visible and

Computational spectrometer based on spectral encoding directly captures the “fingerprint” of an object. However, the

Here, the authors present a chip-scale spectrometer through synergizing MEMS modulation and autoencoder

In this article, we propose a systematic approach based on deep learning for the intelligent design of spectral encoding

Conventional spectrometer designs necessitate a compromise between their resolution and sensitivity, especially as

By applying light pulses and gate voltage pulses, our miniaturized spectrometer can realize image-encoding and

Neural network-based on-chip spectroscopy using a scalable plasmonic encoder. Credit: UCLA Engineering Institute

Conventional spectrometers can be bulky and efforts are being made to develop miniaturised versions. Here,

the

Spectroscopy and Spectrometers Spatial-spectral encoding and dictionary optimization in compressive

Spectral reflectance or transmittance measurements provide intrinsic information on the material of an object and are

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