AthermalGuide
APVV-25-0467

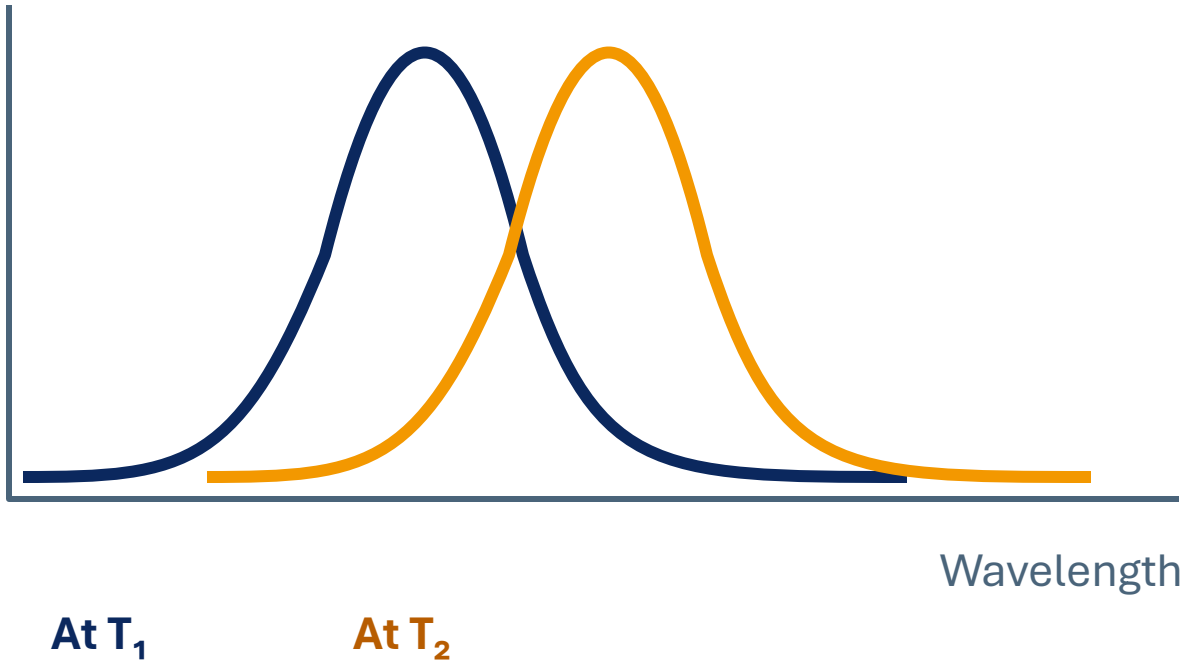
Keeping optical filters on wavelength

How a polymer cladding compensates thermal drift in a silicon oxynitride waveguide

Applied Research on an Athermal SiON Photonic Platform

Why a filter drifts with temperature

Transmission at one output



Illustrative spectra

The passband can drift away from a fixed laser wavelength.

Temperature changes the effective index and the physical length of each waveguide arm.

The athermal condition

Optical path difference between adjacent arms

$$n \times \Delta L$$

n = effective index of the guided mode

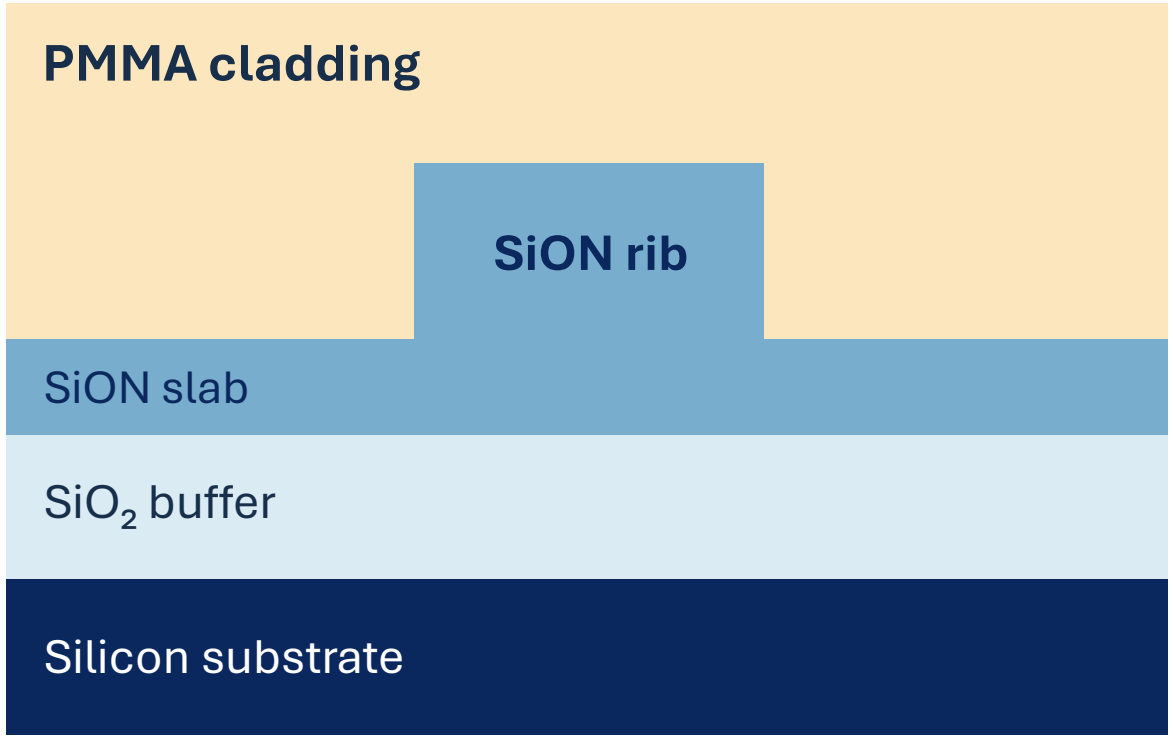
ΔL = physical path-length increment

As silicon expands, ΔL increases.

The design needs n to decrease just enough to cancel that increase.

$$\frac{1}{n}\frac{\partial n}{\partial T} \approx -\alpha_{Si}$$

How a polymer cladding supplies compensation



Rib waveguide cross-section, schematic

Material response near 1.55 µm

PMMA $-170 \times 10^{-6}\ K^{-1}$

SiON $+12.85 \times 10^{-6}\ K^{-1}$

The optical field extends into both. Rib dimensions and SiON composition control how much they each contribute.

Thermal drift predicted for one rib geometry

0.718

pm/°C

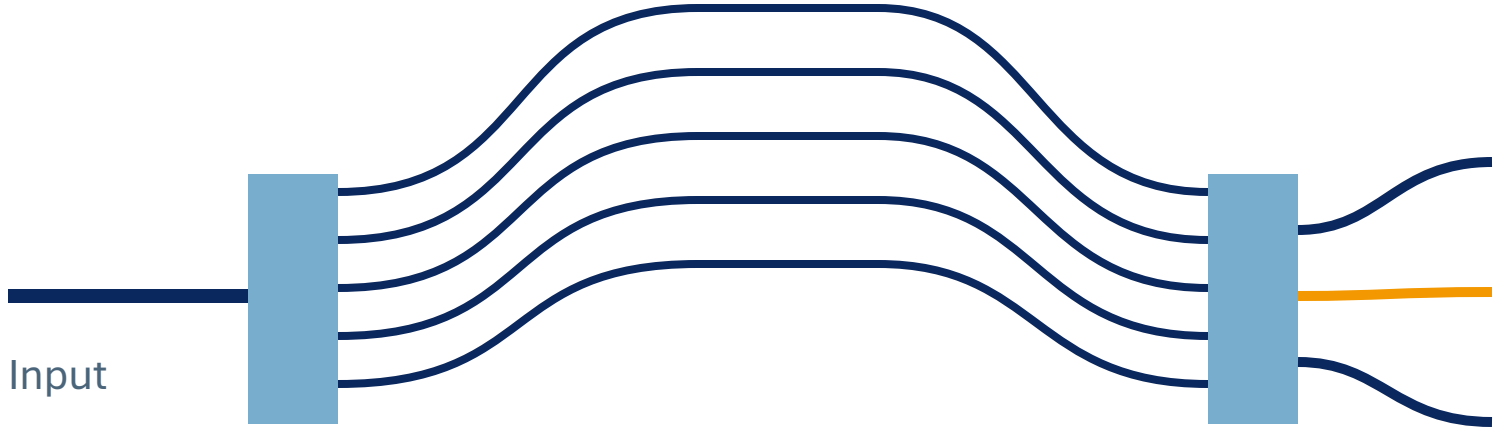
Modelled central-wavelength shift near 1550 nm

Simulated design

Rib width	**2.5 µm**
Slab height	**0.8 µm**
SiON core index	**1.5611**
Temperature range	**–40 to +80 °C**

A cyclic filter for optical access networks

Arrayed waveguide grating (AWG)



Array arms with successive length increments

20 channels

100 GHz spacing

≈2.2 THz free spectral range

OPAL 2026 simulated design for Super-PON

How the platform will be tested

Fabricate

Ring resonators, unbalanced Mach–Zehnder interferometers and AWG filters.

Thermally cycle

Cool and heat the chip from −40 to +80 °C in dry nitrogen to prevent condensation.

Measure drift

Track resonance wavelengths and phase changes. Repeat the cycle to test repeatability.

Two fabrication and validation cycles will inform the design rules

Planned output: a process design kit for passive SiON photonic components.

A design question for the next fabrication run

The filter peak shifts to longer wavelengths as the chip warms.

Should the mode overlap more or less with the PMMA cladding?

Assume the substrate, materials and operating wavelength stay the same.



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