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Photo-induced Refractive Index change in Germanosilicate Optical Fibres: Electronic Change or Physical Change?

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These gratings can be used:

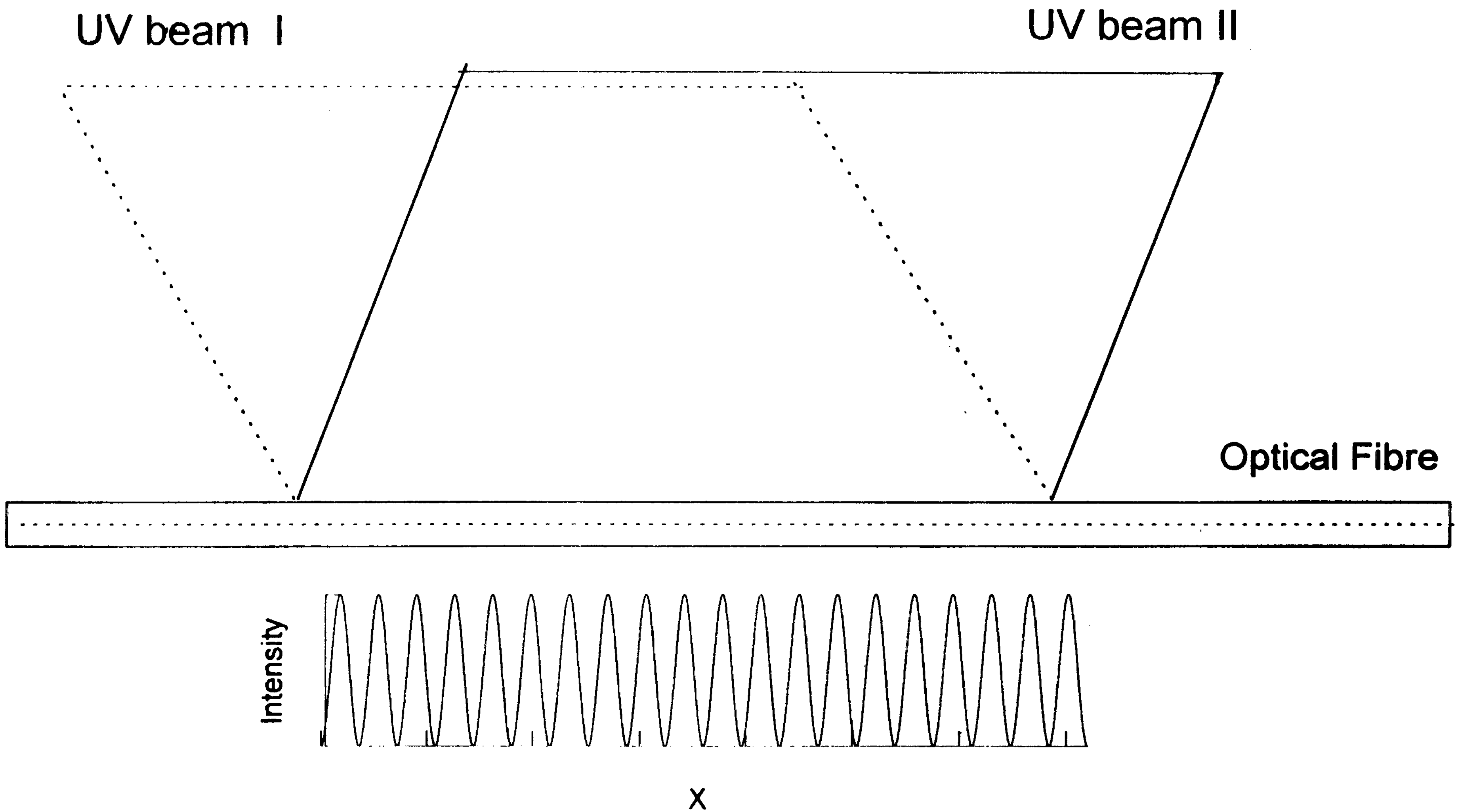
I. as Bandstop filters

II. to construct bandpass filters

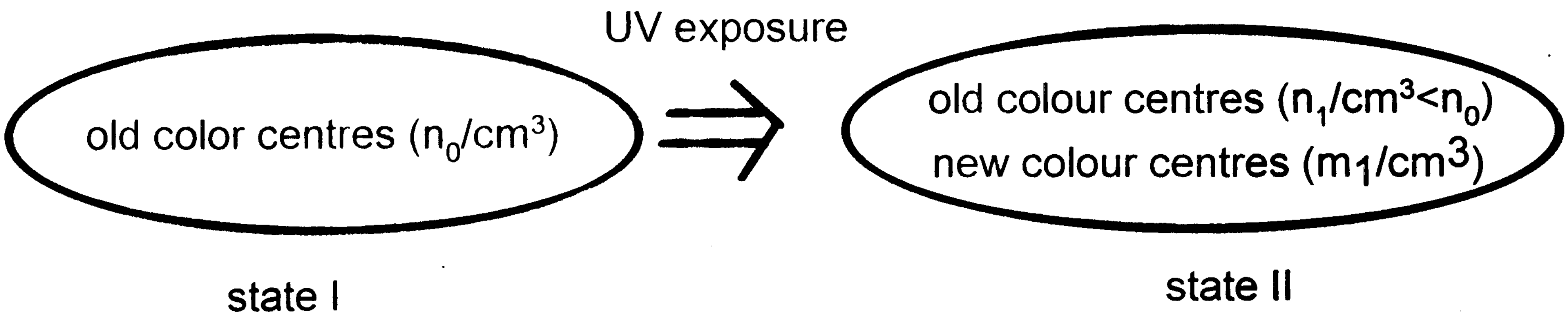
III. as WDM demultiplexers

IV. as reflectors for single frequency fibre lasers

Writing of in-core fibre gratings



Colour Centre Model



state II has a different absorption spectrum therefore a different index

<u>In germanosilicate glass</u>

State I = germanium-related oxygen deficient centres (GeO defects or Ge-Ge wrong bonds) (GODC) with an absoption band at 242nm

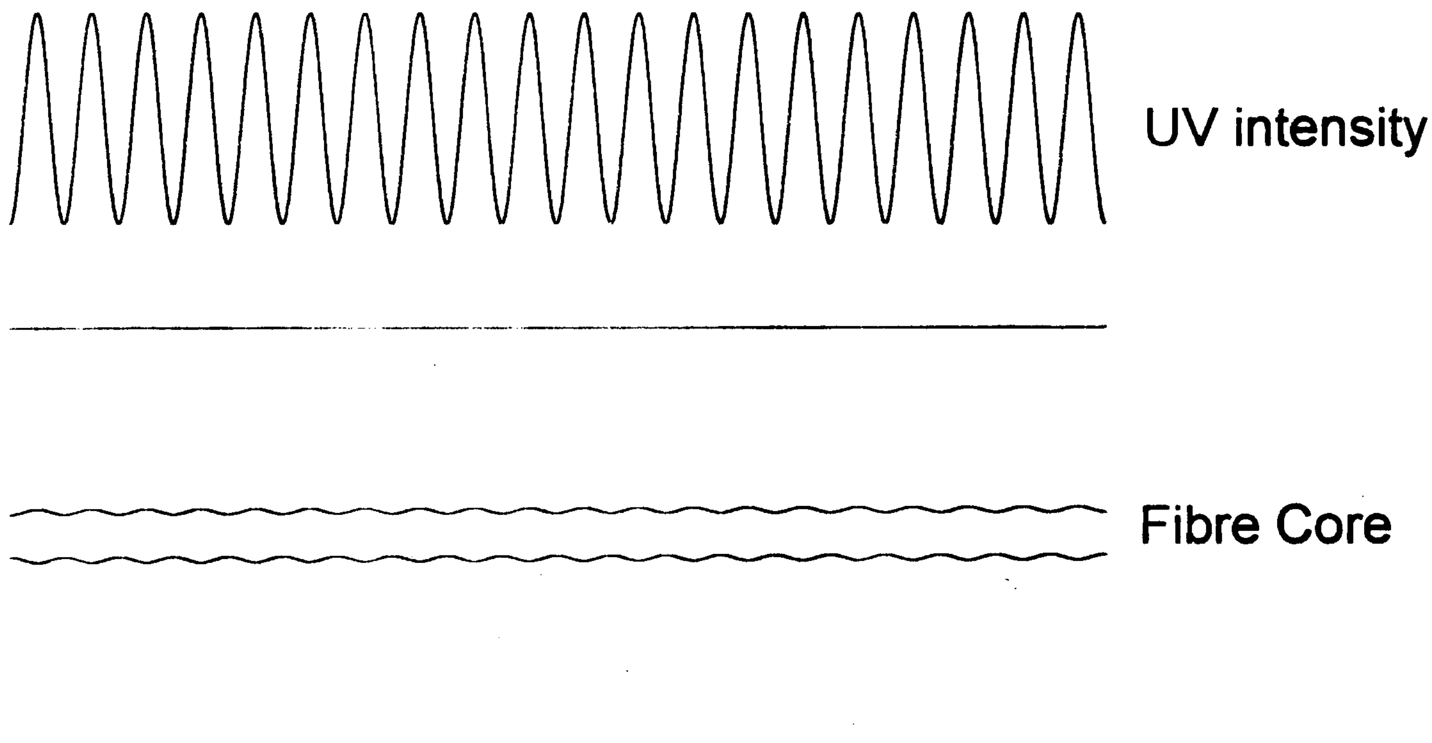
state II= reduced number of GODC and new bands at 195nm (possibly Ge-related), weak bands at 224nm, 256nm, 183nm and 175nm

To explain the 10^{-4} index change in IR,it requires <u>several hundred dB/mm</u> change in absorption in UV

Compaction Theory

a) fast injection (20ns) of energy causes local heating

b) local annealing leads to local compaction



Kramers-Kronig Relation

$$n(\omega) - 1 = \frac{2}{\pi} \int_0^\infty d\varpi \, \frac{K(\omega)\,\varpi}{\varpi^2 - \omega^2}$$

$$k(\omega) = \frac{2}{\pi} \int_0^\infty d\varpi \, \frac{n(\omega)\,\omega}{\omega^2 - \varpi^2}$$

where

$$\varepsilon(\omega) = (n(\omega) + iK(\omega))^2$$

$$\Delta n(\omega) = \frac{c}{\pi}\int_0^\infty d\varpi \frac{\Delta\alpha(\varpi)}{\varpi^2 - \omega^2}$$

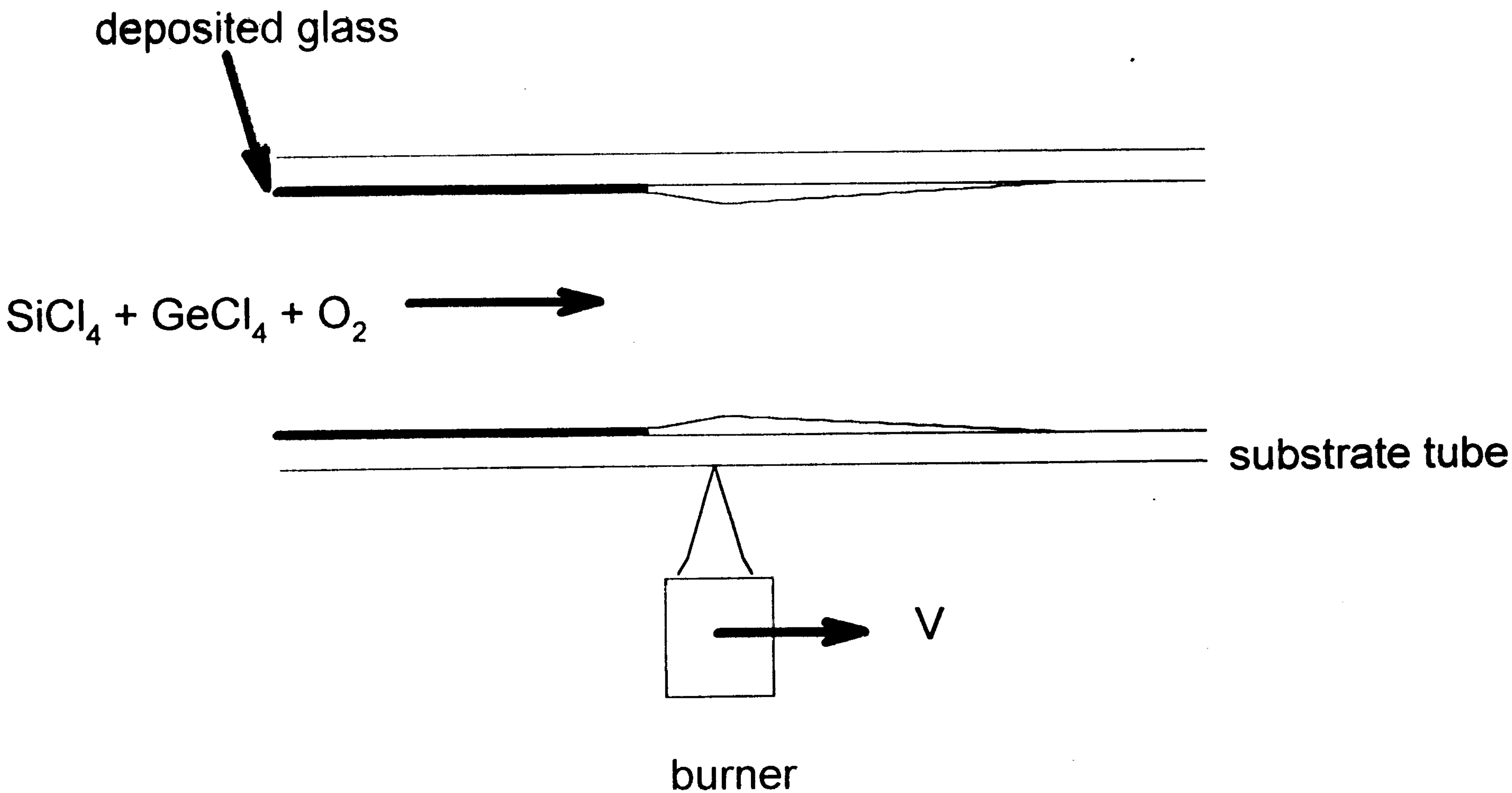
where

Δn: change in refractive index

Δ*α*: change in absorption coefficient

c: speed of light in vacuum

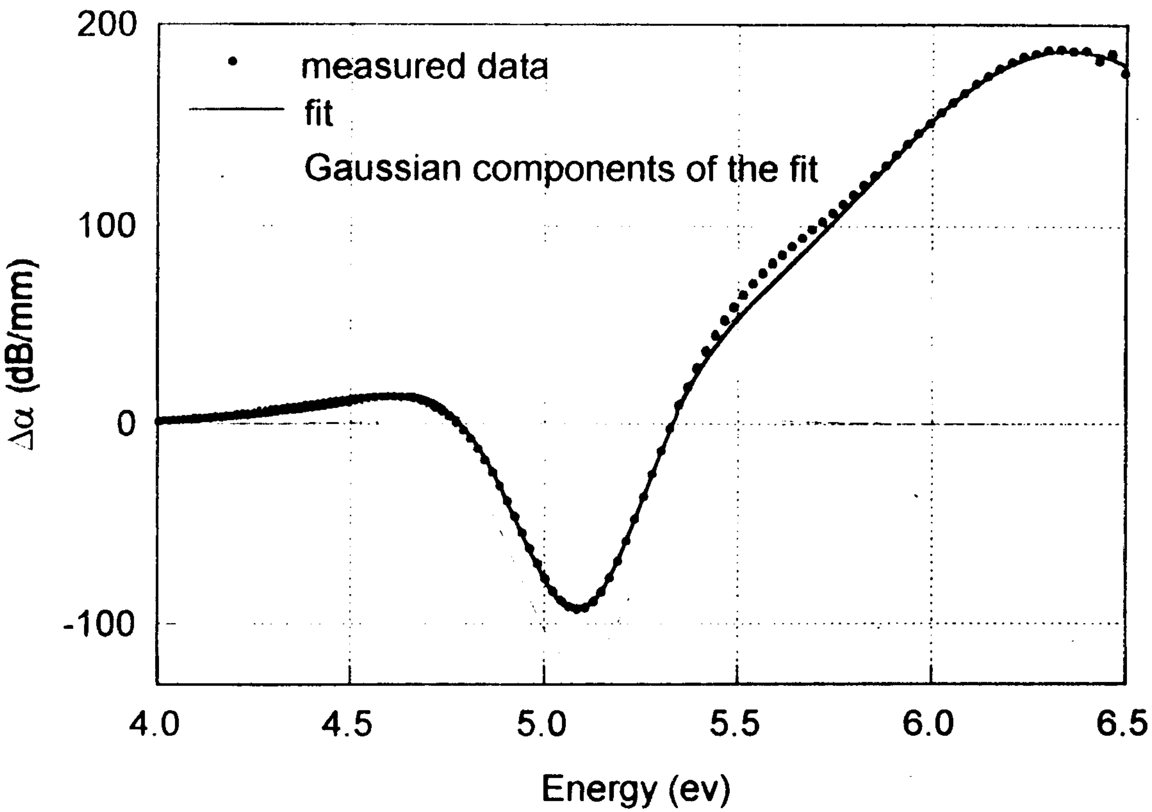
Modified Chemical Vapour Deposition



UV-induced absorption change

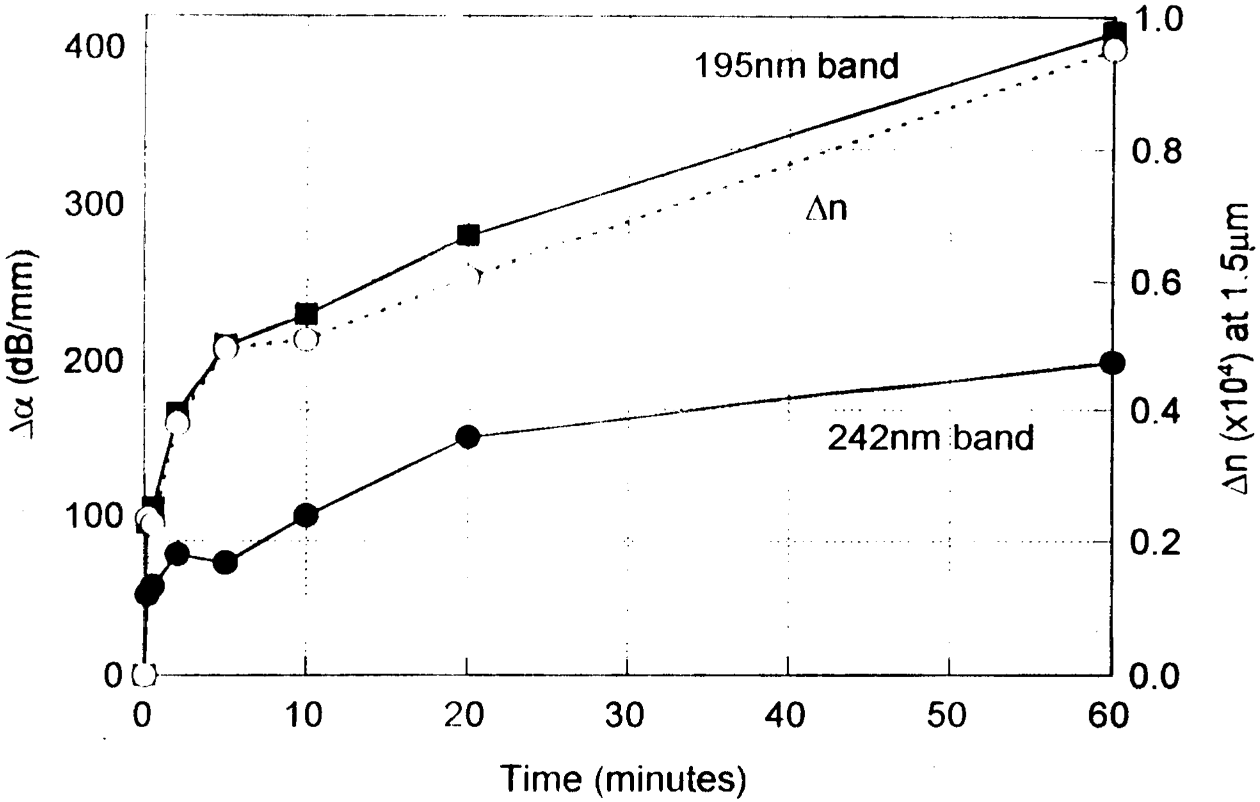
<u>main features</u>: reduction in 242nm band, increase in 195nm band

<u>other features</u>: weak bands at 224nm, 256nm, 183nm, and 175nm



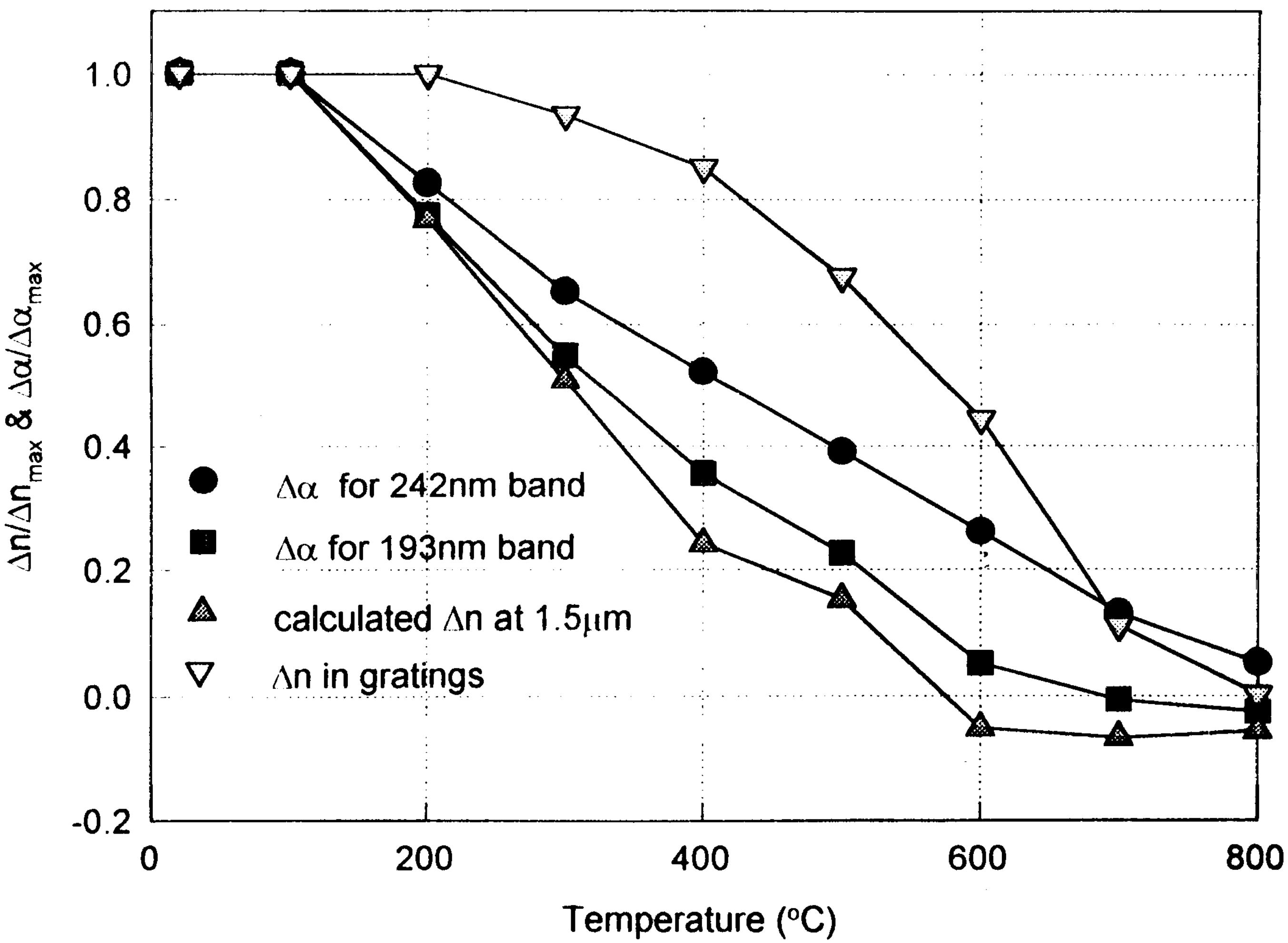
Dynamics of Absorption Change

NA=0.18 (8.3mol% GeO_2), 0.9mJ/mm²/pulse.



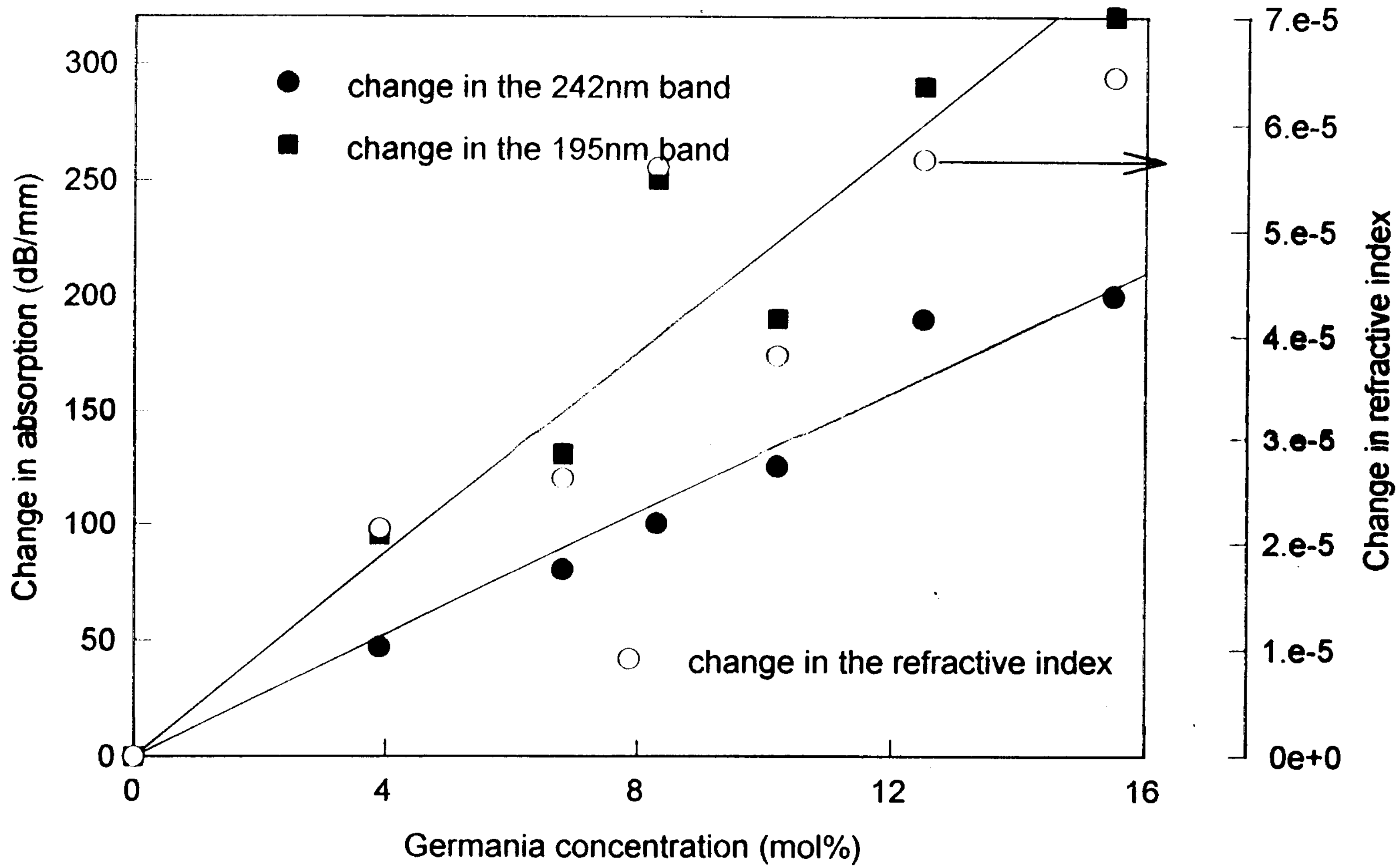
Effect of Thermal Annealing

NA=0.2, heating rate=10°C/min, dwell=10mins



GeO2 Concentration Dependence

0.6mJ/mm^2/pulse, 20mins



Conclusions

I. The Strong UV-induced absorption change in germanosilicate preforms has been resolved with a simple and accurate method.

II. The UV-induced absorption change can account for the 10^{-4} index change in fibre gratings.

III. Thermal annealing characteristics of the absorption change is also similar to that of the index change in fibre gratings