Absorbtion Of SiON Waveguides

File name: `SiON waveguide.apc`

Reference: K. Worhoff, P. V. Lambeck and A. Driessen, "*Design, Tolerance Analysis and Fabrication of Silicon Oxynitride Based Planar Optical Waveguides for Communication Devices*", Jornal of Lightwave Technol., Vol. 17, No. 8, pp. 1401-1407, August 1999.

This example shows how external data can be used to define variables, and how a variable can be expressed as a function of another one.

Silicon Oxinitride is an excellent material for the realization of medium contrast planar integrated optics circuits. However, due to the unavoidable N-H bounds presents in the material, a peak absorption around a wavelength of 1510 nm can impact on the performance of the circuit. The bell shaped absorption depends on the index contrast Δn, on the technological process (annealing, deuterated material, etc.) and on the dimension of the waveguide and can be modelled with the following fitting formula

$$\alpha = \frac{(A-D)}{2}\left[\frac{1}{1+B(\lambda-\lambda_{p1})^2} + \exp\left(-\frac{(\lambda-\lambda_{p2})^2}{C}\right)\right] + D \quad dB/cm$$

where λ_{p1} and λ_{p2} are the peak absorption wavelengths respectively due to the Lorentzian and the Gaussian contributes, A is the peak absorption, B and C define the width of the absorption peak and D is the material loss contribute far away from the absorption peak.

Some example of coefficient derived from measured spectral attenuations are
Δn=2.5% index contrast SiON waveguide with an attenuation peak of 0.45 dB/cm at the wavelength λ_p=1506 nm is described by A=0.45, B=3000, C=0.000504135, λ_{p1}=1.50616, λ_{p2}=1.50569 and D=0.0211103;
Δn=6.0% index contrast SiON waveguide with an attenuation peak of 3.48 dB/cm at the wavelength λ_p=1507 nm is described by A=3.48, B=3000, C=0.000298746, λ_{p1}=1.50534, λ_{p2}=1.50763 and D=0.01;

In this example a simple straight waveguide realized in SiON technology with an index contrast of 6% is analysed. The measured attenuation of the waveguide is read from the data file `Absorbtion_SiON60.txt` and used in the simulation. The 'Variables' panel and in Parameter panel of the straight waveguide the definition of the attenuation is clearly visible.
Fig. 1 show the spectral insertion loss of a 1cm long waveguide. ASPIC interpolates and extrapolates data where missing. The second straight waveguide uses the above fitting formula to calculate waveguide losses and figure 1 shows both spectral behaviours, superimposed. The agreement is fairly good.

An example of the impact of such a wavelength dependence on a single ring resonator filter is shown in Fig. 2. Note that around the absorption peak the extinction ratio reduces and the bandwidth increases because of a higher absorption.

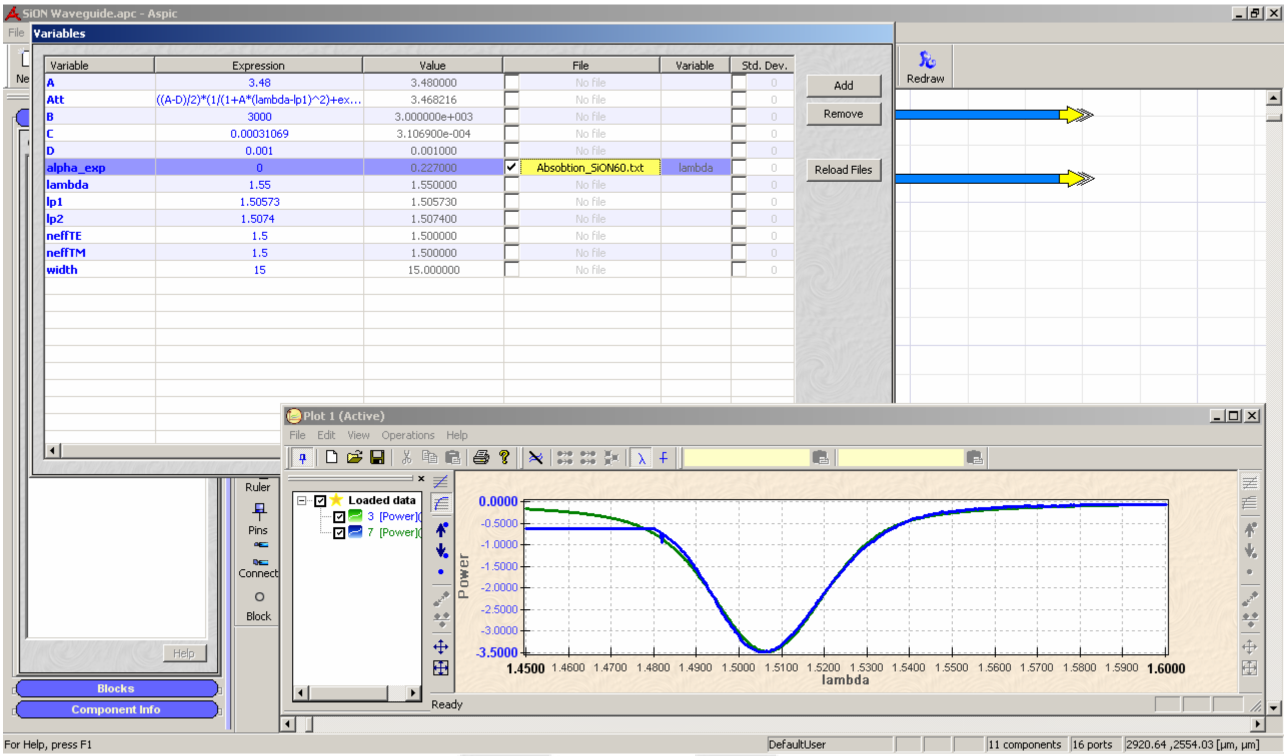

Fig. 1 – Spectral insertion loss of a SiON waveguide. In blue the measured data; in green the fitted behaviour

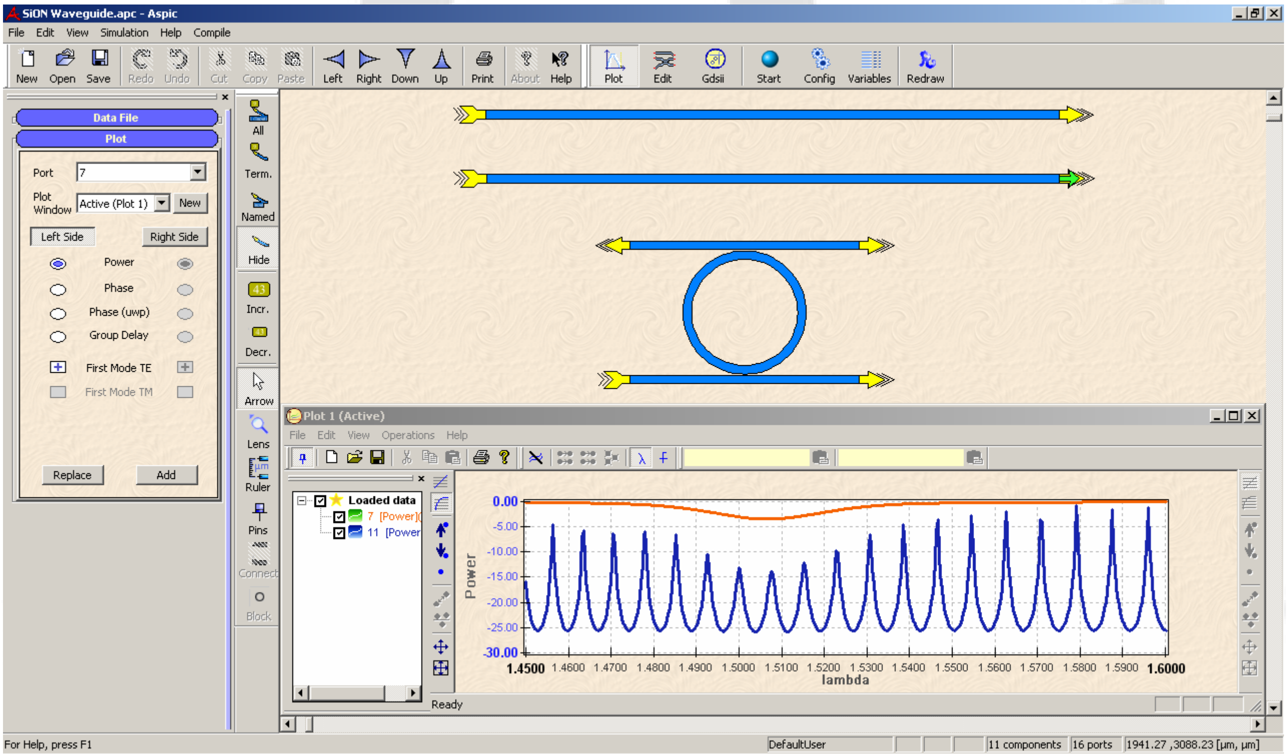

Fig. 2 – Spectral behaviour of a lossy ring resonator