



Mathematical description of absorbance spectra and redox in a Fe and Ce doped silicate glass

T T Volotinen and J M Parker

Dept. of Engineering Materials, The University of Sheffield, U.K.



Introduction

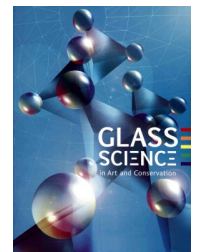
Good quality wine deserves to be protected from the sun's radiation, particularly blue and UV light, by the bottle material during long term storage in shops. This work explores, how the absorbance spectrum of a 15soda-15lime-70silica glass doped with Ce and Fe can be adjusted to provide such protection. The wine should also appear appetising i.e. the glass colour matters.

Results

- Fe^{2+} ions can be oxidised to Fe^{3+} ions by adding CeO_2 to the batch.
 - The absorbance spectra of Fe^{2+} , Fe^{3+} , Ce^{3+} and Ce^{4+} ions are described by summed Gaussian peaks, and calibrated using the literature data^{1,2,3}.
- ∇⇒ The concentration of these ions can be accurately measured from the measured absorbance spectra.



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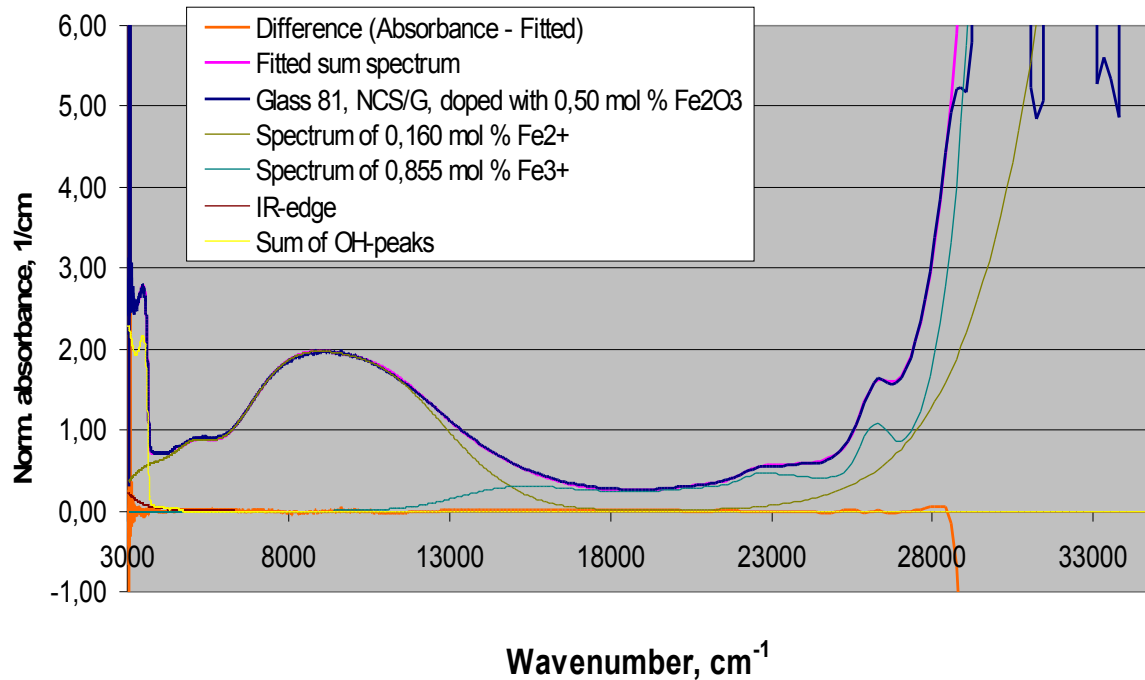
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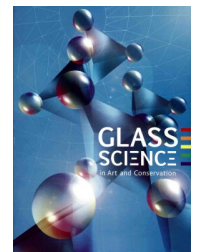
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Measured and fitted absorbance spectrum of a Fe-doped glass



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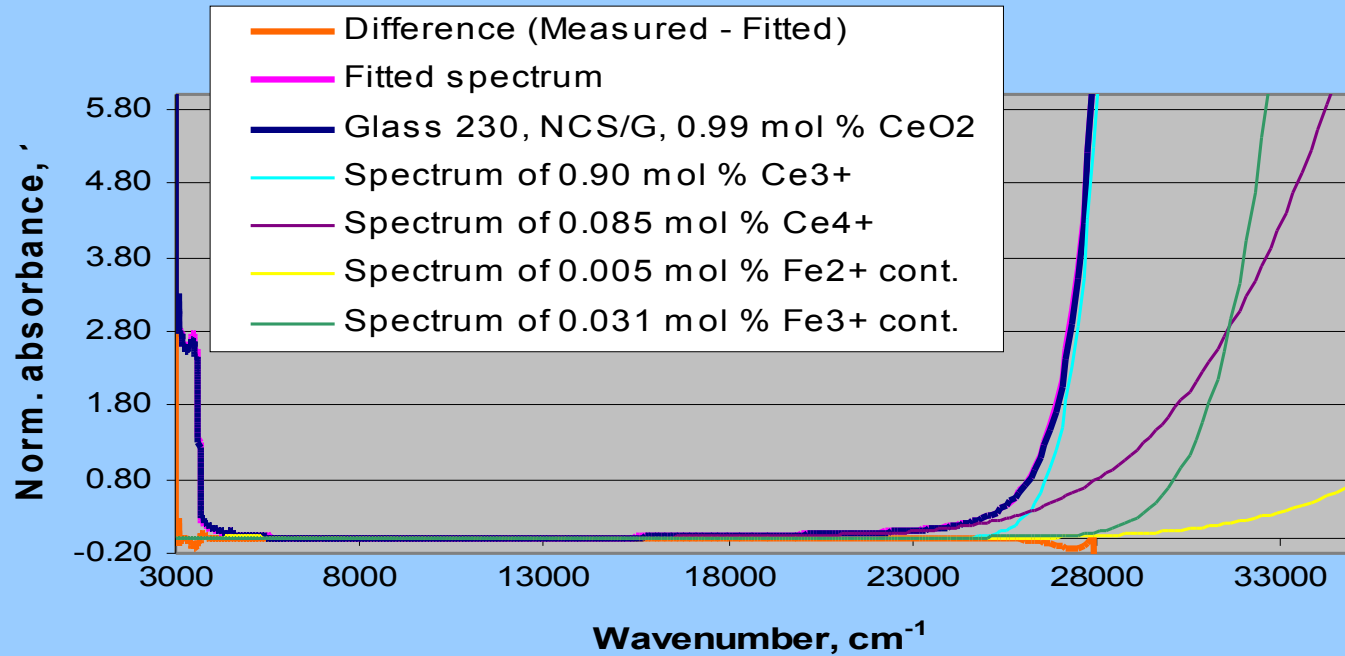
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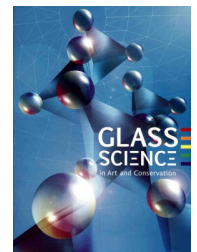
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Measured and fitted absorbance spectrum of a Ce-doped glass



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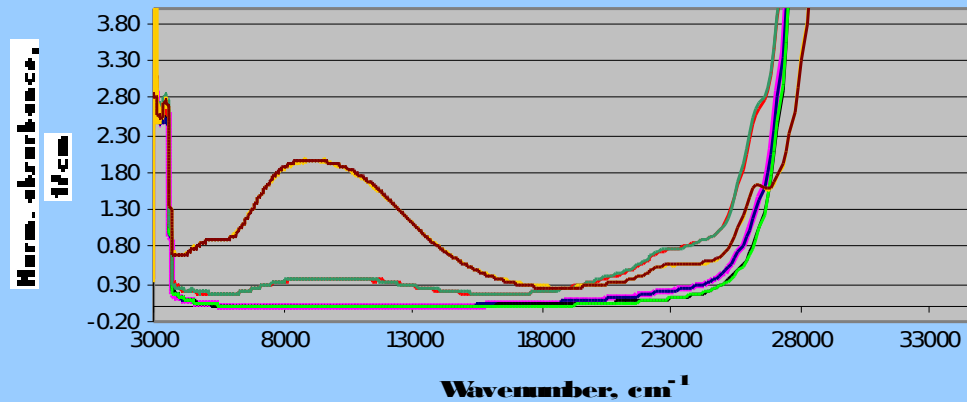
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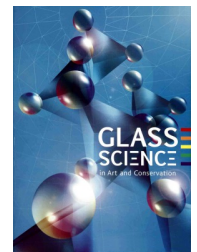
Measured and fitted absorbance spectra of the Ce and Fe doped glasses



- 231, Fitted spectrum
- 231, NCS/G, 0.10 mol % Fe₂O₃ + 0.99 mol % CeO₂
- 230, NCS/G, 0.99 mol % CeO₂
- Fitted spectrum
- 208, NCS/G, 0.49 mol % Fe₂O₃ + 0.99 mol % CeO₂
- Fitted spectrum
- Glass 81, NCS/G, doped with 0,50 mol % Fe₂O₃
- Fitted sum spectrum



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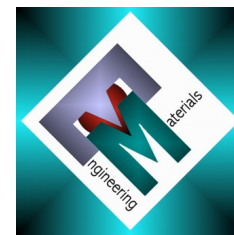




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Conclusions

- Ion concentrations: $[Ce^{3+}]$, $[Ce^{4+}]$, $[Fe^{2+}]$ and $[Fe^{3+}]$ and redox ratios can be defined from the measured absorbance spectrum with the fitting method.
- A UV- and short visible wavelength absorbing glass can be obtained by using Fe and Ce as dopants.
- The colour of the glass can be chosen between a green and yellow hue by choosing a suitable proportion between Ce and Fe dopant concentrations.
- The absorbance spectrum and glass colour can be designed by computer for a known host glass.

Literature

1. Volotinen, Tarja T, 2007, PhD Thesis, Sheffield University.
2. Paul, A and Douglas, R W, 1965, Phys. and Chem. of Glasses, Vol. 6, No. 6, p. 212 – 215.
3. Paje S E et al, 2001, Optical Materials, Vol. 17, p. 459 – 469.



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