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A Study of Tellurite Glasses for Electro-optic Optical Fibre Devices

by

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School of Chemistry & Physics

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Declaration of Authorship

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List of Publications

1. Manning, Sean; Ebendorff-Heidepriem, Heike; Heike Monro, Tanya Mary.
   Sodium Zinc Tellurite Glass: a Candidate Material for Core/Clad Fibres for Electro-optic Devices.
   Proceedings of the 9th Pacific Rim Conference on Ceramic and Glass Technology (PACRIM9), held in Cairns, Queensland, Australia July 10-14 2011.

2. Manning, Sean; Monro, Tanya Mary; Munch, Jesper; Ottaway, David John.
   Improved maker fringes data analysis using genetic algorithms.
   Proceedings of the Australasian Conference on Optics, Lasers and Spectroscopy and Australian Conference on Optical Fibre Technology in association with the International Workshop on Dissipative Solitons 2009.

3. Manning, Sean; Ebendorff-Heidepriem, Heike; Monro, Tanya Mary; Munch, Jesper.
   Tellurite glasses for photonic devices with enhanced nonlinearity.
   Proceedings of the 8th Pacific Rim Conference on Ceramic and Glass Technology (PACRIM8), held in Vancouver, British Columbia, Canada May 31- June 5 2009.

4. Manning, Sean; Monro, Tanya Mary; Munch, Jesper; Ottaway, David John.
   On the application of genetic algorithms to maker fringes analysis.
   18th Australian Institute of Physics (AIP) Congress Conference, held in Adelaide, South Australia Nov 30-Dec 5 2008..

"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."

Richard P. Feynman

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Abstract

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Optical fibre devices that can control light via the application of electric fields are of enormous technological interest. These so called electro-optic devices have potential applications in many varied places, such as data systems, pulsed lasers and sensing technologies.

We have identified tellurium dioxide (tellurite) based glasses as being especially suitable for electro-optic fibre devices owing to their large nonlinear coefficients and high crystallisation stabilities. Furthermore, tellurite glass is compatible with the extrusion technique for producing optical fibre preforms, this being a fabrication strength of our research group.

We developed tellurite glasses based on the general formula $10\mathrm{Na_2O}.x\mathrm{MO}.(90-x)\mathrm{TeO_2}$ with M=Magnesium, Zinc and Barium and $x = 5,\ 10,\ 15$ and 20. Raman spectroscopy was utilised to determine the structure of the glasses under study, from which definite compositional trends were observed. Further, we measured physical, thermal and optical properties of these glasses that are critical for the design of electro-optical optical fibres. Certain of these properties displayed compositional trends that were correlated with the structural data, thus indicating physical origins for the properties. This information can thus be used to guide future glass composition design.

We investigated thermal poling as a potential post processing technique for inducing second order nonlinearities thereby enhancing the efficiency of the electro-optic effects. The Maker fringes technique was applied to measuring the induced second order nonlinearities. We have made refinements to the standard way in which these measurements are made, both in terms of the experimental technique as well as the analysis of the data.

We developed computational models of optical fibres with internal electrodes for determining the properties, such as optical attenuation resulting from the presence of internal electrodes. The results of these computations in combination with the measurements of the glass properties are used to guide the design of prototype electro-optic fibres. Finally, we developed various techniques for the fabrication of electro-optic fibre devices, such as optical fibre preform extrusion, fibre drawing techniques and electrode insertion.

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For my wife, who deserves a PhD in patience.