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

by

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Faculty of Science
School of Chemistry & Physics

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Declaration of Authorship

I, Sean Manning, declare that this thesis titled, ‘A Study of Tellurite Glasses for Electro-optic Optical Fibre Devices’ and the work presented in it are my own. I confirm that:

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List of Publications

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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

THE UNIVERSITY OF ADELAIDE

Abstract

Faculty of Science
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Doctor of Philosophy

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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 $10\text{Na}_2\text{O}.x\text{MO}.(90-x)\text{TeO}_2$ 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.