

Anthony William Wren *B.Sc., M.Sc., PhD.*

CAMPUS ADDRESS

Rm. 218 Binns Merrill Hall, Inamori School of Engineering, Alfred University, 14802 NY, USA.

e-mail: wren@alfred.edu, Office: 607-871-2183

Status: Citizen of the European Union (EU), US Permanent Resident (Greencard).

CURRENT POSITION

Period:

2011 (*Aug.*) – Present

Position:

Assistant Professor

Employer:

Inamori School of Engineering, Alfred University, USA.

Role:

Research into Bioactive Materials for Clinical Applications.

POSTDOCTORAL RESEARCH

Period:

2009 (*Oct.*) - 2011 (*Aug.*)

2008 (*Nov.*) – 2009 (*Oct.*)

Employer:

Inamori School of Engineering.

Materials & Surface Science Institute (MSSI).

Alfred University, New York, USA.

University of Limerick, Ireland.

EDUCATION / QUALIFICATIONS

Period:

2005 (*Oct.*) – 2008 (*Nov.*)

2004 (*Oct.*) – 2005 (*Sept.*)

2004 (*Sept.*) – 2004 (*Oct.*)

1998 (*Sept.*) – 2003 (*Jun.*)

Qualification:

PhD. - Biomaterials. ‘Strontium Substituted Glass Polyalkenoate Cements for Skeletal Applications’.
University of Limerick, Ireland.

M.Sc. - Biomedical Engineering*. ‘A Novel Screening Method for the Detection of Osteoporosis’.
University of Limerick, Ireland.

Certificate - Anatomy & Physiology – Part of M.Sc. Program

Royal College of Surgeons in Ireland.

B.Sc. - Science (Hons). Biology (*major*), Mathematics, Experimental Physics, Mathematical Physics.

National University of Ireland Maynooth, Ireland.

RESEARCH PROFILE

RESEARCH INTERESTS

- Characterization of novel bioactive glass structure and corrosion of in fluid environments.
- Dex-CMC Hydrogel based carriers for delivery of therapeutic ionic constituents from degradable bioactive glasses.
- Novel glass polyalkenoate (GPC) based bone adhesives for skeletal restoration.
- Bioceramic scaffolds applicability to aid in recovery from spinal cord injury.
- Cytocompatibility of Mammalian Cells (*L929 Fibroblasts*, *MC3T3 Osteoblasts*, *MG-63 Osteosarcoma*, *Schwann Cells* and *Multiple Myeloma Cells*) in response to bioceramics degradation and ion release.
- *In-vitro* microbiology testing of bacteria (*E. coli*, *S. epidermidis*, *P. aeruginosa*, *B. fragilis*, *S. aureus*, VRSA) and fungi (*C. albicans*) of bioceramics with respect to material solubility and incubation time.

FUNDING PROFILEStart Up Funds

- Alfred University Start Up funds - **\$65k**.

Government Sponsored Students

- Government of Thailand (1018.216557). PhD full scholarship (C. Yatongchai). **\$206k**.
 - "Hydroxyapatite doped with bioactive glass particles for skeletal reconstruction"
- Brazil Scientific Mobility Program Academic Training (Aug-Sept 2015) (Roger Borges).
 - "Characterization of Ti, Cu and Ge glasses for skeletal GIC based adhesives".

US Federal Sponsored Awards

- National Science Foundation (SBIR-PI) - Transparent Materials (Rochester NY) – **\$150k (Co-PI)**.
 - "Bioactive High Contrast Agents For Orthopaedic and Bone Applications".
- National Institute of Health (NIH-R21) - University of Maryland/Alfred University - **\$402 (Co-PI)**
 - "Bioinspired Composites for Dental Restoration".
- Summer Intern sponsorship for Undergraduate student (Summer 2013 – **\$8k**.
 - "Bioactive High Contrast Agents For Orthopaedic and Bone Applications".

Funding Acquired through Outreach Programs

- Outreach Program - Children and Youth Learning Initiative 2014 – **\$2.6k**.
 - Outreach program – Belfast Central High-School – 20 students, 4hr/day over 4 visits.
- Outreach Program - Children and Youth Learning Initiative 2015 – **\$2.3k**.
 - Bolivar-Richburg High School – 19 Students, 6hr/day over 2 visits.
- Outreach Program - Children and Youth Learning Initiative 2015 – **\$2.3k**.
 - Belfast Central High-School – 20 students, 6hr/day over 2 visits.

GRADUATE RESEARCH SUPERVISION

Student	Degree	Project Description	Additional Information
C. Yatongchai	PhD	Hydroxyapatite – glass based nano-composites for skeletal applications.	<ul style="list-style-type: none"> Graduated 2015 4 publications.
Lana Placek	PhD	Yttrium/Cerium containing glass ceramic scaffolds to aid in spinal cord injury.	<ul style="list-style-type: none"> Graduating 2016 1 publication.
Tim Keenan (Co-adv. <u>Dr. Hall</u>)	PhD	Dex-CMC based hydrogels for controlled delivery of ionic dissolution products of gallium bioactive glasses.	<ul style="list-style-type: none"> Graduating 2016 2 publications.
Sahar Muktari	PhD	Investigating the interfacial bond strength of Cu, Ge and Ti based glass ionomer cements for skeletal repair.	
Yiming Li	MSc	Investigating the effect of Na ⁺ and Sr ²⁺ on the bioactivity of SiO ₂ -TiO ₂ -CaO-Na ₂ O/SrO glasses and ceramics.	<ul style="list-style-type: none"> Graduated 2014 4 publications.
Simon Chon	MSc	Investigating the influence of TiO ₂ incorporation into bioactive glass in relation to glass solubility and bioactivity.	

UNDERGRADUATE RESEARCH SUPERVISION

Academic advisor to sophomore, junior & senior Biomaterials Engineering Students (BES).

2015 Student Name**Project Topic**

- Kiel Skelly Determining the interfacial bond strength of dental adhesive resins.

- Dan Wilkinson Evaluating the biocompatibility of Ti containing bioactive glass.

2014 Student Name**Project Topic**

- Maeve Toomey Glass characterization and ion release of thermally treated glass.
- Harley Cleary Solubility of bioactivity of heat treated glass based Ti-GPCs.
- Connor Spike Rheology and mechanical testing of heat treated glass based Ti-GPCs.
- Nathaniel Yard Diffusion and surface changes of Ti-GPCs through bone mineral.
- Luke Jaeger Characterization of TiO₂, GeO₂, CuO Bioactive glasses.

2013 Student Name**Project Topic**

- Courtney Smith Solubility / cytocompatibility of Ag microspheres.
- Matt Strohmayer BIS-GMA/Carbon nanotube composite bone adhesives.
- Kelly Jo Beck Characterization of TiO₂ Containing Glass-Ceramic Scaffolds.
- Peter Saunders Biodegradable PLGA Microspheres with Encapsulated Lysozyme.
- Heather Liggett Investigation of osteoblast cell populations via cyclic voltammetry.
- Caelen Clark Imaging of Osteoblast adhesion on TiO₂ nanotube substrates.
- Nicole Keenan Evaluating the stability of Bioactive glass doped hydrogels.
- Lydia Boutelle Antibacterial silver doped hydrogels: efficacy against *S. aureus*.
- Scott De Franco Norton Biocompatibility of magnesium oxides for coronary stent applications.

2012 Student Name**Project Topic**

- Laura Haas Antibacterial silver coated glass microspheres.
- Emily Allen Bioactivity of gallium based glass polyalkenoate cements.
- Tracie McGinnity* Surface reactivity of bioactive gallium glasses.
- Kelly Jo Beck Injectability of carboxymethylcellulose doped with bioactive glass.
- Douglas Cohen* PLGA microspheres synthesis doped with protein.
- James Whyel Characterization of bioactive composites filler particles.
- Matthew Elmer Modification of Torlon polymer with carbon nanotubes.

* *Outstanding Research Award presented by Sigma Xi, the research honors society.*

INDEPENDENT STUDY RESEARCH STUDENTS

- Yuxuan Gong (2015) Controllable nanostructured AgO thin films using chemical bath method.
- Katie Weiss (2014) Vancomycin doped PLGA microspheres: synthesis & antimicrobial effect.
- Olivia Parker (2014) Erythromycin doped PLGA microspheres: synthesis & antimicrobial effect.
- Yiming Li (2013) Investigating the solubility of Na/Sr bioactive glass in flowing water.

SUMMER STUDY RESEARCH STUDENTS

- Roger Borges (2015) Characterization of Cu, Ti, Ge GPCs. (University ABC, Sao Paulo, Brazil).
- Lindsay Piraino (2015) Ce/Y bioceramics to aid in spinal cord injury. (Alfred University).
- Matt Strohmayer (2013) Bioactive contrast agents for orthopedic repair. (Alfred University/Transparent Material).
- Courtney Smith (2013) Ag coating solubility of glass microspheres. (Alfred University/E-Lead Program).

PEER-REVIEWED RESEARCH PUBLICATIONS

- Author/Co-Author of 55 Peer Reviewed Scientific Journal Publications.
- Author of Book Chapter: X-Ray Photoelectron Spectroscopy (Nova Publishing, 2011).

Publications 2016

- 1) Investigating the Structure and Biocompatibility of Niobium and Titanium Oxides as Coatings for Orthopedic Metallic Implants. **D. Pradhan, A.W. Wren, S.T. Misture, N.P. Mellott.** *Materials Science and Engineering C*. 58: 918-926 2015.
- 2) Antibacterial properties of poly (octanediol citrate)/Gallium-containing bioglass composite scaffolds. **E. Zeimaran, S. Pourshahrestani, I. Djordjevic, B. Pingguan-Murphy, N. Adib Kadri, A.W. Wren, M.R. Towler.** *Journal of Materials Science: Materials in Medicine*. Accepted Manuscript.

Publications 2015

- 3) Relating Ion Release and pH to in vitro Cell Viability for Gallium-Inclusive Bioactive Glasses. **T.J. Keenan, L.M. Placek, T.L. McGinnity, M.R. Towler, M.M. Hall, A.W. Wren.** *Journal of Materials Science*. doi:10.1007/s10853-015-9442-x.
- 4) Characterization of silica-based and borate-based, titanium-containing bioactive glasses for coating metallic implants. **O.A.R. Perez, D. Curran, M. Papini, E. Schemitsch, P. Zalzal, M.R. Towler.** *Journal of Non-Crystalline Solids*. dx.doi.org/10.1016/j.jnoncrysol.2015.09.026.
- 5) Recycling of waste amber glass and porcine bone into fast sintered and high strength glass foams. **Y. Gong, R. Dongol, C. Yatongchai, A.W. Wren, S.K. Sundaram, N.P. Mellott.** *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2015.09.052.
- 6) Investigating the Effect of TiO₂ Substitution on the Structure and Solubility of Bioactive glass. **L.M. Placek, T.J. Keenan, Y. Li, C. Yatongchai, D. Pradhan, D. Boyd, N.P. Mellott, A.W. Wren.** *Journal of Biomedical Materials Research Part B*. doi: 10.1002/jbm.b.33521 2015.
- 7) Investigating the effect of silver coating on the solubility, antibacterial properties and cytocompatibility of SiO₂-Na₂O-CaO glass microspheres. **L.M. Haas, C.M. Smith, L.M. Placek, M.M. Hall, Y. Gong, N.P. Mellott, A.W. Wren.** *Journal of Biomaterials Applications*. doi: 10.1177/0885328215591902 2015.
- 8) Investigating the addition of SiO₂-CaO-ZnO-Na₂O-TiO₂ Bioactive Glass to Hydroxyapatite: Characterization, Mechanical Properties and Bioactivity. **C. Yatongchai, L.M. Placek, D.J. Curran, M.R. Towler, A.W. Wren.** *Journal of Biomaterials Applications*. doi: 10.1177/0885328215592866 2015.
- 9) Synthesis, characterization and antimicrobial activity of hydrogels doped with bioactive glass. **A.W. Wren, A. Coughlan, P. Hassanzadeh, T.J. Keenan, L.R. Boutelle, M.R. Towler.** *Journal of Macromolecular Bioscience*. 15: (8) 1146-58 2015.
- 10) Investigating the influence of Na⁺ and Sr²⁺ on the structure and solubility of SiO₂-TiO₂-CaO-Na₂O/SrO bioactive glass. **Y. Li, A. Coughlan, F.R. Laffir, D. Pradhan, N.P. Mellott, A.W. Wren.** *Journal of Materials Science: Materials in Medicine*. 26: (2) 1-12 2015.
- 11) Quantitative morphological and compositional evaluation of alumino-borosilicate glass surfaces. **Y. Gong, A.W. Wren, N.P. Mellott.** *Applied Surface Science*. 324: 594–604 2015.
- 12) Characterization of hydroxyapatite-glass composites using terahertz time-domain spectroscopy. **C. Yatongchai, A.W. Wren, S.K. Sundaram.** *Journal of Infrared, Millimeter and Terahertz Waves* 36: (1) 81-93 2015.
- 13) Investigating the solubility and cytocompatibility of CaO-Na₂O-SiO₂/TiO₂ bioactive glasses. **A.W. Wren, A. Coughlan, C.M. Smith, S.P. Hudson, F.R. Laffir, M.R. Towler.** *Journal of Biomedical Materials Research Part A*. 103: (2) 709-720 2015.

- 14) A glass polyalkenoate cement carrier for bone morphogenetic proteins. **A.M.F. Alhalawani, O. Rodriguez, D.J. Curran, A.W. Wren, T.J. Keenan, G. Crasto, S.A.F. Peel, M.R. Towler.** *Journal of Functional Materials*. 26:151 2015.
- Publications 2014
- 15) An Investigation into the structure, solubility and therapeutic potential of Sol-Gel SiO₂-CaO-Ga₂O₃ glass-ceramics. **A.W. Wren, M.C. Jones, S.T. Misture, A. Coughlan, M.R. Towler, M.M. Hall.** *Materials Chemistry and Physics*. 148: 416-425 2014.
- 16) Influence of gallium on the surface properties of zinc based glass polyalkenoate cements. **A.M.F. Alhalawani, L.M. Placek, A.W. Wren, D.J. Curran, D. Boyd, M.R. Towler.** *Materials Chemistry and Physics*. 147: (3) 360-364 2014.
- 17) Reintroducing Sborgite: crystallization through exposure of sodium borosilicate glasses to humidity. **Y. Gong C. Yatongchai, A.W. Wren, N.P. Mellott.** *Materials Letters*. 136: 265-270 2014.
- 18) Investigating the surface reactivity of SiO₂-TiO₂-CaO-Na₂O/SrO bioceramics as a function of structure and incubation time in Simulated Body Fluid. **Y. Li, A. Coughlan, A.W. Wren.** *Journal of Material Science: Materials in Medicine*. 25: (8) 1853-1864 2014.
- 19) Investigating the effect of SiO₂-TiO₂-CaO-Na₂O-ZnO bioactive glass doped hydroxyapatite – characterization and structural evaluation. **C. Yatongchai, A.W. Wren, D.J. Curran, S. Hampshire, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 25: (7) 1645-59 2014.
- 20) Titanium-Vanadium oxide nanocomposites: synthesis, characterization and antibacterial activity. **A.W. Wren, B.M. Adams, M.R. Towler, N.P. Mellott.** *Thin Solid Films*. 144: (15) 538-546 2014.
- 21) Drug-eluting composite materials: a comparative study using Vancomycin and RNPA1000 to inhibit growth of *Staphylococcus aureus* **T.M. Eidem, A. Coughlan, M.R. Towler, P.M. Dunman, A.W. Wren.** *Journal of Biomaterials Applications*. 28: (8) 1235-1246 2014.
- Publications 2013
- 22) Investigating the Mechanical Durability of Bioactive Glasses as a Function of Structure, Solubility and Incubation Time. **Y. Li, A. Coughlan, F.R Laffir, Dimple Pradhan, N.P Mellott, A.W. Wren.** *Journal of Non-Crystalline Solids*. 380: 25-34 2013.
- 23) The Effect of Glass Synthesis Route on Setting Behavior and Mechanical Properties of Glass Ionomer Cements. **I.Y. Kim, C. Ohtsuki, A. Coughlan, L. Placek, A.W. Wren, M.R Towler.** *Journal of Material Science: Materials in Medicine*. 24: 2677-2682 2013.
- 24) Comparison of SiO₂-CaO-ZnO-SrO glass polyalkenoate cement to commercial dental materials: ion release, biocompatibility and antibacterial properties. **A.W. Wren, A. Coughlan, M.J. German, M.M. Hall, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 24: (9) 2255-64 2013.
- 25) Characterization of Ga₂O₃-Na₂O-CaO-ZnO-SiO₂ Bioactive Glasses. **A.W. Wren, T. Keenan, A. Coughlan, F.R. Laffir, D. Boyd, M.R. Towler, M.M. Hall.** *Journal of Material Science*. 48: 3999-4007 2013.
- 26) Aluminium-free glass polyalkenoate cements: Ion release and *in-vitro* antibacterial efficacy. **A.W. Wren, J.P. Hansen, S. Hayakawa & M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 24: (5) 1167-78 2013.
- 27) Comparison of the Weibull characteristics of hydroxyapatite and strontium doped hydroxyapatite **C. Yatongchai, A.W. Wren, D.J. Curran, J-C. Hornez, M.R. Towler.** *Journal of the Mechanical Behavior of Biomedical Materials*. 21C: 95-108 2013.
- 28) Structure and diffusion of ZnO-SrO-CaO-Na₂O-SiO₂ bioactive glasses: a combined high energy X-ray diffraction and molecular dynamics simulations study. **Y. Xiang, J. Du, A.W. Wren, D.J. Boyd, M. R. Towler.** *RSC Advances*. 3: 5966-5978 2013.
- 29) Comparison of a SiO₂-CaO-ZnO-SrO glass polyalkenoate cement to commercial dental materials: Glass structure and physical properties. **A.W. Wren, A. Coughlan, F.R. Laffir, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 24: (2) 271-280 2013.

Publications 2012

- 30) Processing, characterization and bactericidal activity of undoped and silver doped vanadium oxides. **M.E. Tousley, A.W. Wren, M.R. Towler, N.P. Mellott.** *Materials, Chemistry & Physics*. 137: (12) 596-603 2012
- 31) Fabrication of CaO-NaO-SiO₂/TiO₂ scaffolds for surgical applications. **A.W. Wren, A. Coughlan, K.E. Smale, S.T. Misture, B.P. Mahon, O.M. Clarkin, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 23: 2881-2891 2012.
- 32) Characterization and antibacterial efficacy of silver coated Ca-Na-Zn-Si/Ti glasses. **A.W. Wren, B.A. Akgun, B.M. Adams, A. Coughlan, N.P. Mellott, M.R. Towler.** *Journal of Biomaterials Applications*. 27: (4) 433-443 2012.
- 33) Gallium containing glass polyalkenoate anti-cancerous bone cements: glass characterization and physical properties. **A.W. Wren, A. Coughlan, L. Placek, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 23: (8) 1823-1833 2012.
- 34) Silver coated bioactive glass particles for wound healing applications. **A.W. Wren, A. Coughlan, P. Hassanzadeh, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 23 (5) 1331-41 2012.

Publications 2011

- 35) Solgel derived silver incorporated titania thin films on glass: bactericidal and photocatalytic activity. **B.A. Akgun, A.W. Wren, C. Durucan, M.R. Towler, N.P. Mellott,** *Journal of Sol-Gel Science*. 59: (2) 228-238 2011.
- 36) The structural role of titanium in Ca-Sr-Zn-Si/Ti glasses for medical applications. **A.W. Wren, A. Kidari, F.R. Laffir, M.R. Towler.** *Journal of Non-Crystalline Solids*. 357: (3) 1021-1026 2011.
- 37) The bioactivity and ion release of titanium-containing glass polyalkenoate cements for medical applications. **A.W. Wren, N.M. Cummins, F.R. Laffir, S.P. Hudson, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 22: 19-28 2011.

Publications 2010

- 38) Raman spectroscopy of fingernails: a novel tool for evaluation of bone quality? **N.M. Cummins, J.C.C. Day, A.W. Wren, P. Carroll, N. Murphy, P.M. Jakeman, M.R. Towler.** *Spec. Biomed. App*. 24: (5) 517-524 2010.
- 39) The effect of ionic dissolution products of Ca-Sr-Na-Zn-Si bioactive glass on *in vitro* cytocompatibility. **S. Murphy, A.W. Wren, M.R. Towler, D. Boyd.** *Journal of Material Science: Materials in Medicine*. 10: 2827-34 2010.
- 40) A spectroscopic investigation into the setting and mechanical properties of titanium containing glass ionomer cements. **A.W. Wren, N.M. Cummins, A. Kidari, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 21: (8) 2355-2364 2010.
- 41) The effect of biological additives on the material and biological properties of Ca-Sr-Zn-Si glass polyalkenoate cements **A.W. Wren, N.M. Cummins, M.R. Towler.** *Journal of Material Science*. 45: (13) 3554-3562 2010.
- 42) Comparison of antibacterial properties of commercial bone cements/fillers with a zinc-based glass polyalkenoate cement. **A.W. Wren, N.M. Cummins, M.R. Towler.** *Journal of Material Science*. 45: (19) 5244 2010.
- 43) Influence of morphology and processing on XPS characterisation of SrO-Ca-ZnO-SiO₂ glass. **F.R. Laffir, A.W. Wren, M.R. Towler.** *Journal of Material Science*. 45: (11) 3102-3105 2010.
- 44) Antibacterial analysis of a zinc-based glass polyalkenoate cement. **O.M. Clarkin, A.W. Wren, R. Thornton, J.C. Cooney, M.R. Towler.** *Journal of Biomaterials Applications*. 26: (3) 277-292 2010.
- 45) Evaluation of two novel aluminum-free, zinc-based glass polyalkenoate cements as alternatives to pmma bone cement for use in vertebroplasty and balloon kyphoplasty. **G. Lewis, M.R. Towler, D. Boyd, M.J. German, A.W. Wren, O.M. Clarkin, A. Yates.** *Journal of Material Science: Materials in Medicine*. 21: 59-66 2010.

Publications 2009

- 46) The effect of glass synthesis route on mechanical and physical properties of resultant glass ionomer cements. **A.W. Wren, O.M. Clarkin, F.R. Laffir, C. Ohtsuki, I.Y. Kim, M.R. Towler.** *Journal of Material Science: Materials in Medicine*. 20: (10) 1991-1999 2009.

- 47) Fabrication of spherical CaO–SrO–ZnO–SiO₂ particles by sol–gel processing. **I.Y. Kim, M.R. Towler, A.W. Wren, C. Ohtsuki.** *Journal of Material Science: Materials in Medicine.* 20: (11) 2267-2273 2009.
- 48) Analysis of γ -Irradiated synthetic bone grafts by calorimetry, XRD and ²⁹Si MAS-NMR spectroscopy. **D. Boyd, S. Murphy, M.R. Towler, A.W. Wren, S. Hayakawa.** *Journal of Non-Crystalline Solids.* 355: 45-47 2285-2288 2009.
- 49) Antibacterial properties of a tri-sodium citrate modified glass polyalkenoate cement. **A.W. Wren, D. Boyd, R. Thornton, J.C. Cooney, M. R. Towler.** *Journal of Biomedical Materials Research: Part B.* 90: (2) 700-709 2009.
- Publications 2008
- 50) The role Sr²⁺ on the structure and reactivity of SrO-CaO-ZnO-SiO₂ ionomer glasses. **D. Boyd, M.R. Towler, S. Watts, R.G. Hill, A.W. Wren, O.M. Clarkin.** *Journal of Material Science: Materials in Medicine.* 19: 953-957 2008.
- 51) Zinc-based glass polyalkenoate cements with improved setting times and mechanical properties. **D. Boyd, O.M. Clarkin, A.W. Wren, M.R. Towler.** *Acta Biomaterialia.* 4: 425-431 2008.
- 52) The processing, mechanical properties and bioactivity of strontium based glass polyalkenoate cements. **A.W. Wren, O.M. Clarkin, D. Boyd, M.R. Towler.** *Journal of Material Science: Materials in Medicine.* 19: 1737-1743 2008.
- 53) TEM analysis of apatite surface layers observed on zinc based glass polyalkenoate cements. **D. Boyd, M.R. Towler, A.W. Wren, O.M. Clarkin, D.A. Tanner.** *Journal of Material Science.* 43: 1170–1173 2008.
- 54) Comparison of an experimental bone cement with Surgical Simplex P, Spineplex and Cortoss. **D. Boyd, M.R. Towler, A.W. Wren, O.M. Clarkin.** *Journal of Material Science: Materials in Medicine.* 19: (4) 1745-1752 2008.
- Publications 2007
- 55) Raman spectroscopy of the human nail: a potential tool for evaluating bone health? **M.R. Towler, A.W. Wren, N. Rushe, J. Saunders, N.M. Cummins, P.M. Jakeman.** *Journal of Material Science: Materials in Medicine.* 18: 759-763 2007.
- Book Chapter Contribution
- 1) **X-Ray Photoelectron Spectroscopy: Studies from Industrial and Bioactive Glasses to Biomaterials.** **A.W. Wren, F.R. Laffir, N.P. Mellott, M.R. Towler.** Alfred University. Nova Publishing. 2010.

TEACHING PROFILE

COURSE DESCRIPTION

CEMS 368 - Introduction to Bioengineering.

- This course explores all concepts related to developing materials, tissues and medical devices that are currently employed to improve the quality of life for people who have experienced disease, require prosthetic limbs or any physiological condition requiring surgical intervention. Specifically topics include, Bioethics and FDA regulatory affairs, biomaterials, tissue engineering, medical devices, medical imaging techniques, basics of anatomy and physiology, natural materials, .

CEMS 466 - Skeletal Tissue.

- This course identified the anatomy and physiology of hard tissues within the human body such as bone, cartilage and dental tissues. The more prevalent diseases of these tissues are highlighted and the current surgical repair strategies are identified that are not related to the use of synthetic materials.

CEMS 465 - Biocompatibility.

- This course looks at how the corrosion of synthetic materials (glasses, ceramics, metals, polymers) can affect living tissues and the types of implantable materials we can use to re-establish functional tissues. This includes reactions to foreign

materials, hypersensitivity, immune reactions, bulk/surface erosion of materials in addition to bone, skin and nerve synthetic repair mechanisms.

ENGR 111 - Explorations in Biomaterials.

- This course is an introduction to biomaterials which includes a basic overview of some of the area relevant to biomaterial development, including material synthesis and characterization, mechanical testing, rheological testing and antibacterial testing. This course has a 2 hour laboratory each week to give students hands on experience in our biomaterials laboratory.

CEMS 334 - Introduction to Polymers.

- This course includes the fundamental of organic polymer chemistry and the associated structures and polymerization mechanisms. Topics within this course include polymer chemistry, polymer processing, mechanics and flow of polymers, characterization and processing methods and biopolymers employed in medicine and industrial applications, and recycling of polymers.

UNDERGRADUATE / GRADUATE COURSE CURRICULUM

Course No.	Course Title	Contents	Credits
• CEMS 368	Introduction to Bioengineering.	Lecture	3
• CEMS 466	Skeletal Tissue.	Lecture	3
• CEMS 465	Biocompatibility.	Lecture	3 / 4
• ENGR 111	Explorations in Biomaterials.	Lecture/Lab	1
• CEMS 334	Introduction to Polymers.	Lecture	3

Teaching Schedule 2011-2015.

Course	2011 - 12		2012 - 13		2013 - 14		2014 - 15		2015 - 16	
	F	S	F	S	F	S	F	S	F	S
ENGR 111 (UG)	-	X (25)		X (17)		X (9)		X (25)		X ()
CEMS 334 (UG)		X (21)		X (20)						
CEMS 465 (UG/G)			X (10)		X (12)		X (5)		X (7)	
CEMS 466 (UG/G)						X (8)		X (6)		X ()
CEMS 368 (UG)							X (10)		X (12)	

UG = Undergrad, G = Graduate, F = Fall Semester, S = Spring Semester, X = Course Taught, () = Enrollment.

- BIOL 202 – Biology Laboratory Instructor.

CAMPUS ACTIVITIES

- AU Committees: ABET Accreditation, Graduate Qualifier Examination, Ceramics Research, Library, Biosafety Committee.
- Faculty Search Committees – Various Candidates Appointed to Biology Dept.
- Faculty Representative to Undergraduate Alfred Biomaterials Chapter (ABC).
- Outreach Service – Women in Science and Engineering (WISE), High-School (Belfast Central High-School, Catteragus High School, Bolivar Central High School) visits to Biomaterials Lab.
- AU Open Days – Biomaterials Representative.
- Biomaterials Laboratory Lead and Operations Manager for Common Use: *Cell Culture & Microbiology Laboratory, Materials Solubility Suite, Bioactive Glass Processing Laboratory.*

PROFESSIONAL SERVICE AND DEVELOPMENT

- Reviewer – Career Award, National Science Foundation, Washington DC, Oct 2012.
- Reviewer for Graduate Scholarships - UNCF-Merck Science Initiative.
- BMES 2015 Abstract Reviewer. 2015 Annual meeting, Tampa, Florida. October 7-10th 2015.
- Reviewer for Abstract Submissions - 8th International Conference on Materials Science and Technology, December 15-16, 2014, Swissotel Le Concorde, Bangkok, Thailand.
- Reviewer for ARGUS (Alfred Research Grants for Undergraduates) proposals at Alfred University.
- Reviewer for Master's (M.Sc.) Program for the University at Buffalo School of Dental Medicine.
- Reviewer for Professional Journals:

• <i>Acta Biomaterialia</i>	• <i>International Journal of Applied Glass Science</i>
• <i>Advanced Healthcare Materials</i>	• <i>Materials Research Innovations</i>
• <i>Journal of Materials Research</i>	• <i>ACS Applied Materials and Interfaces</i>
• <i>Journal of Material Science: Materials in Medicine</i>	• <i>Advances in Condensed Matter Physics</i>
• <i>Journal of Biomedical Materials Research</i>	• <i>Journal of Industrial and Engineering Chemistry</i>
• <i>Journal of Biomedical Materials</i>	• <i>Materials Chemistry and Physics</i>
• <i>International Journal of Nanomedicine</i>	• <i>Journal of Solgel Science and Technology</i>
• <i>Journal of Biomaterials Applications</i>	• <i>Journal of the American Ceramic Society</i>
• <i>Biomedical Glasses</i>	• <i>Journal of Vacuum Science and Technology</i>
• <i>Future Sciences Group – Book Publisher</i>	• <i>International Journal of Molecular Sciences</i>

INVITED PRESENTATIONS

- 1) Bioactive Glass-Hydrogel composites for hard tissue applications. **A.W. Wren**. *Materials Science & Technology*. October 4-8th, 2015. Columbus, OH, USA.
- 2) Glass Based Biomaterials for Hard Tissue Restoration. **A.W. Wren**. *Ryerson University, School of Engineering*. March 17th, 2015, Toronto, Canada.
- 3) The Influence of Bioactive Glass/Ceramic Ionic Dissolution Products on the Bioactivity of Hard Tissue Biomaterials. **A.W. Wren**. *39th International Conference and Expo on Advanced Ceramics and Composites*. January 25-30th 2015, Daytona Beach, FL, USA.
- 4) Modifying the Chemistry of Dental Adhesives to Improve their Orthopedic Applicability. **A.W. Wren**. *Materials Science & Technology*. October 12-16th, 2014. Pittsburgh PA, USA.
- 5) Applying Glass to Medicine. **A.W. Wren**. *Ryerson University, School of Engineering*. June 20th 2014, Toronto Canada.
- 6) Biomaterials from Glass?. **A.W. Wren**. *SUNY Downstate Medical Center*. New York. Nov 8th 2013. Brooklyn, NYC, New York.
- 7) The Development of Orthopaedic Bone Cements from Dental Restorative Materials. **A.W. Wren**. *International Association for Dental Research. University of Buffalo Dental School/Ivoclar Vivadent*. November 4th 2013, Buffalo, NY, USA.

PROFESSIONAL CONTRIBUTIONS

- 1) **Materials Science & Technology**. Next Generation Biomaterials – Session V. Organizer Roger Naryan (UNC/NCSU), Session Chair – **A.W. Wren**. October 4-8th, 2015. Columbus, OH, USA.
- 2) **Materials Science & Technology**. Next Generation Biomaterials – Session III. Organizer Roger Naryan (UNC/NCSU), Session Chair – **A.W. Wren, N.P. Mellott**. October 12-16th, 2014. Pittsburgh, PA, USA.

CONFERENCE PROCEEDINGS

- 1) A glass polyalkenoate cement carrier for bone morphogenic proteins. **A. Alhalawani, O. Rodriguez, D. Curran, R. Co, S. Kieran, S. Arshad, T. Keenan, A. Wren, G. Crasto, S. Peel, M. Towler**. *BMES 2015 Annual Meeting*. October 7-10th 2015, Tampa, FL, USA.
- 2) Cytocompatibility of Y₂O₃ and CeO₂ containing bioactive glasses to aid spinal cord recovery. **L.M Placek, A.W. Wren**. *The 41st Annual Northeast Bioengineering Conference*. April 17-19th 2015. Troy, NY, USA.

- 3) Ga-containing bioactive glass/Dextran-CMC hydrogel composites: ion release and cell viability. **T.J. Keenan, M.M. Hall, A.W. Wren** *The 41st Annual Northeast Bioengineering Conference*. April 17-19th 2015. Troy, NY, USA.
- 4) Effects of Strontium Substitution on Bioactivity of Hydroxyapatite. **C. Yatongchai, L.M. Placek, M.R. Towler, A.W. Wren** *The 41st Annual Northeast Bioengineering Conference*. April 17-19th 2015. Troy, NY, USA.
- 5) Corrosion resistance of niobium and silicon oxide coated stainless steel in prepared physiological fluids. **D. Pradhan, A.W. Wren, D. Liu, N.P. Mellott**. *Materials Science & Technology*. October 12-16th, 2014. Pittsburgh PA, USA.
- 6) Comparison of Hydroxyapatite and Strontium doped Hydroxyapatite: A Weibull Analysis. **C. Yatongchai, A.W. Wren, D.J. Curran, M.R. Towler**. *Biomedical Engineering Society (BMES) Annual Meeting*. September 25-28th, 2014. Seattle, WA, USA.
- 7) Drug Eluting Cements for Hard Tissue Repair: Evaluating efficacy against *S. aureus*. **A.W. Wren, T.M. Eidem, A. Coughlan, P.M. Dunman, M.R. Towler**. *Society for Biomaterials*. April 16-19th 2014. Denver, CO, USA.
- 8) Comparison of the Physical Properties of an Innovative Glass Polyalkenoate Cement to Commercial Dental Materials. **A. Coughlan, F.R. Laffir, M.R. Towler, A.W. Wren**. *Society for Biomaterials*. April 16-19th 2014. Denver CO, USA.
- 9) Characterization and Solubility of Y₂O₃ and CeO₂ Containing Bioactive Glasses to Aid Spinal Cord Recovery. **L.M. Placek, A.W. Wren**. *40th Annual Northeast Bioengineering Conference*. April 25-27th 2014. Northeastern University, Boston, MA, USA.
- 10) Dextran-based hydrogels for in-situ delivery of gallium-containing bioactive glasses. **T.J. Keenan, M.M. Hall, A.W. Wren**. *40th Annual Northeast Bioengineering Conference*. April 25-27th 2014. Northeastern University, Boston, MA, USA.
- 11) Mechanical Durability of Bioactive Glass as a Function of Structure, Solubility and Incubation Time. **Y. Li, A. Coughlan, A.W. Wren**. *40th Annual Northeast Bioengineering Conference*. April 25-27th 2014. Northeastern University, Boston, MA, USA.
- 12) Processing and Mechanical testing of Strontium-Substituted Hydroxyapatite/Glass Composites. **C. Yatongchai, M.R. Towler, A.W. Wren**. *40th Annual Northeast Bioengineering Conference*. April 25-27th 2014. Northeastern University, Boston, MA, USA.
- 13) Aqueous Corrosion of Metal Oxide Sol-Gel Thin Films on Glass. **D. Pradhan, A.W. Wren, N.P. Mellott**. *XVII International Solgel Conference*. August 25-30th 2013. Madrid, Spain.
- 14) Corrosion resistance of oxide coated metal implants. **D. Pradhan, A.W. Wren, N.P. Mellott**. *Materials Science & Technology*. October 27-31st 2013. Montreal Quebec, CA.
- 15) Biocompatibility of CaO-Na₂O-SiO₂/TiO₂ Glass Ceramic Scaffolds for Orthopaedic Applications. **A.W. Wren, A. Coughlan, K.E. Smale, S.T. Misture, B.P. Mahon, O.M. Clarkin, M.R. Towler**. *39th Annual Northeast Bioengineering Conference*. April 5-7th 2013. Syracuse University, NY, USA.
- 16) Characterization and Solubility of SiO₂-TiO₂-CaO-Na₂O/SrO Bioactive Glasses. **Y. Li, A. Coughlan, A.W. Wren**. *39th Annual Northeast Bioengineering Conference*, April 5-7th 2013. Syracuse University, NY, USA.
- 17) An Investigation into the Structure and Properties of CaO-ZnO-SiO₂-TiO₂-Na₂O Bioactive glass/ Hydroxyapatite Composites. **C. Yatongchai, M.R. Towler, A.W. Wren**. *39th Annual Northeast Bioengineering Conference*. April 5-7th 2013. Syracuse University, NY, USA.
- 18) An Exploratory Investigation of the Development and Evaluation of a Novel Selenium Containing Bioactive glass. **A. Coughlan, H.F. Haddad, A.W. Wren, M.M. Hall**. *39th Annual Northeast Bioengineering Conference*. April 5-7th 2013. Syracuse University, NY, USA.
- 19) Structure and Simulated body fluid testing of SiO₂-TiO₂-CaO-Na₂O/SrO Bioactive Glasses. **Y. Li, A. Coughlan, A.W. Wren**. *Masters Level Graduate Research Conference*. April 20th 2013. State University of New York, Brockport, NY, USA.
- 20) Gallium Containing Glass Polyalkenoate Bone Cements: Ion Release and *E. coli* Inhibition. **L. Placek, A.W. Wren, A. Coughlan, M.R. Towler**. *39th Annual Northeast Bioengineering Conference*. April 5-7th 2013. Syracuse University, NY, USA.
- 21) Relating pH and Ion Release from Ga₂O₃-Na₂O-CaO-ZnO-SiO₂ Bioactive Glasses. **T.J. Keenan, A.W. Wren, A. Coughlan, M.R. Towler, M.M. Hall**. *39th Annual Northeast Bioengineering Conference*. April 5-7th 2013. Syracuse University, NY, USA.
- 22) Antimicrobial Properties of Silver Coated Bioactive Glass Particles for Wound Healing Applications. **P. Hassanzadeh, A. W. Wren, M. R. Towler**. *Innovations in Biomedical Materials*. September 10-13th 2012. Hilton North Raleigh-Midtown, NC, USA.

- 23) Structure and Biocompatibility Analysis of Sol-Gel Prepared Niobium and Titanium Oxide with Temperature. **D. Pradhan, A. W. Wren, S. T. Misture, N. P. Mellott.** *Innovations in Biomedical Materials*. September 10-13th 2012, Hilton North Raleigh-Midtown, NC, USA, 2012.
- 24) Silver Coated Bioactive Glasses for Wound Healing Applications. **P. Hassanzadeh, A.W. Wren, M.R. Towler.** *38th Annual Northeast Bioengineering Conference*. March 16-18th 2012. Philadelphia, PA, USA.
- 25) Gallium Containing Glass Polyalkenoate Cement: Glass Characterization and Physical Properties, **L. Placek, A.W. Wren, A. Coughlan, M.R. Towler.** *38th Annual Northeast Bioengineering Conference*. March 16-18th 2012. Philadelphia, PA, USA.
- 26) The Structural Characterization of Ga₂O₃-Na₂O-CaO-ZnO-SiO₂ Bioactive Glass. **T.J. Keenan, A.W. Wren, A. Coughlan, M.M. Hall, M.R. Towler.** *38th Annual Northeast Bioengineering Conference*. March 16-18th 2012. Philadelphia, PA, USA.
- 27) Aluminium-Free Glass Polyalkenoate Spinal Cements. **A.W. Wren, N.M. Cummins, M.R. Towler.** *The 37th Annual Northeast Bioengineering Conference*. April 1-3rd 2011. Troy, NY, USA.
- 28) Aluminium-Free Glass Polyalkenoate Spinal Cements: Mechanical and Rheological Properties. **A.W. Wren, N.M. Cummins, M.R. Towler.** *The 21st Interdisciplinary Research Conference On Injectable Osteoarticular Biomaterials and Bone Augmentation Procedures*. Apr 5th – 7th 2011. Boston, MA, USA.
- 29) The Effect of Adding Biologics to Ca-Sr-Zn-Si Glass Polyalkenoate Cements. **A. Coughlan, N.M. Cummins, A.W. Wren, M.R. Towler.** *The 37th Annual Northeast Bioengineering Conference*. Apr 1-3rd 2011. Troy, NY, USA.
- 30) The Effect of Adding Organic Polymers to Ca-Sr-Zn-Si Glass Polyalkenoate Cement. **A.W. Wren, N.M. Cummins, A. Coughlan, M.R. Towler.** *The 21st Interdisciplinary Research Conference On Injectable Osteoarticular Biomaterials and Bone Augmentation Procedures*. April 5-7th 2011. Boston, MA, USA.
- 31) An *in vitro* & Anti-Bacterial Study of Sr, Zn Co-doped Bioactive Glass. **S. Murphy, D. Crowley, A. O'Brien, H. O'Shea, A.W. Wren, M.R. Towler, D. Boyd.** *24th European Conference on Biomaterials*. September 4-9th 2011. Dublin, Ireland.
- 32) The Effect of Adding Organic Polymers on the Handling & Mechanical Properties & Bioactivity of a Zn Based Glass Polyalkenoate Cement. **A.W. Wren, N.M. Cummins, A. Coughlan, M.R. Towler.** *2010 BMES Annual Fall Meeting*. Oct 6-9th 2010. Texas, USA.
- 33) The Antibacterial Properties and Ion Release Profiles of a Novel Zinc based Glass Polyalkenoate Cement. **A.W. Wren, D. Boyd, R. Thornton, J. Cooney, M.R. Towler.** *American Ceramic Society's 2010 Glass & Optical Materials Division Annual Meeting*. May 16-20th, 2010. Corning, NY, USA.
- 34) A Comparison of the Setting, Exotherm and Antibacterial Properties of a Zinc based Glass Polyalkenoate Cement with a Commercial Bone Cement. **A.W. Wren, D. Boyd, M.R. Towler.** *Society For Biomaterials 2010 Annual Meeting*. April 22nd-24th, 2010. Seattle, WA, USA.
- 35) Bioactive Cements for Spinal Augmentation. **A.W. Wren, M.R. Towler.** *Society For Biomaterials 2010 Annual Meeting*. April 22-24th, 2010. Seattle, WA, USA.
- 36) Fracture Toughness of a Ca-Sr-Zn-Si Glass Polyalkenoate Cement for Skeletal Applications. **A.W. Wren, M.R. Towler.** *Third International Conference on Mechanics of Biomaterials and Tissues*. Dec 13-17th, 2009. Clearwater Beach FL, USA.
- 37) Influence of morphology and processing on XPS characterisation of SrO-CaO-ZnO-SiO₂ glass. **F.R. Laffir, A.W. Wren, M.R. Towler.** *13th European Conference on Applications of Surface Science and Interface Analysis*. Oct 13-23rd, 2009. Antalya, Turkey.
- 38) The Antibacterial Properties & Ion Release Profiles of a Novel TSC Modified Glass Polyalkenoate Cement. **A.W. Wren, D. Boyd, R. Thornton, J. Cooney, M.R. Towler.** *United Kingdom Society of Biomaterials*. July 1-4th, 2009. Belfast, Northern Ireland.
- 39) Preparation of Glass Ionomers in the CaO-SrO-ZnO-SiO₂ System. **I.Y. Kim, M.R. Towler, A.W. Wren, C. Ohtsuki.** *Nagoya University Global COE in Chemistry, 2nd Annual Symposium*. June 9th, 2009. Nagoya University, Japan.
- 40) Structural Analysis of γ -Sterilised Synthetic Bone Grafts using Calorimetry & ²⁹Si MAS-NMR Spectroscopy. **D. Boyd, S. Murphy, M.R. Towler, A.W. Wren, S. Hayakawa.** *22nd European Conference on Biomaterials*. September 08-12th, 2009. Lausanne, Switzerland.

- 41) Comparison of an Experimental Bone Cement with Surgical Simplex P[®], Spineplex[™] and Cortoss[®]. **A.W. Wren, O. Clarkin, D. Boyd, and M.R. Towler.** *8th World Biomaterials Congress.* May 28th - Jun 1st, 2008. Amsterdam, Netherlands.
- 42) The Processing, Mechanical Properties and Bioactivity of Strontium Based Glass Polyalkenoate Cements. **A.W. Wren, D. Boyd, M.R. Towler.** *8th World Biomaterials Congress.* May 28th - Jun 1st, 2008. Amsterdam, Netherlands.
- 43) Zinc Based Glass Polyalkenoate Cements with Optimised Rheology and Mechanical Properties. **A.W. Wren, D. Boyd, O.M. Clarkin, M.R. Towler.** *21st European Conference on Biomaterials.* September 09th-12th, 2007. Brighton, UK.
- 44) The Role of Sr²⁺ on the Structure and Reactivity of SrO-CaO-ZnO-SiO₂ Ionomer Glasses. **O.M. Clarkin, D. Boyd, A.W. Wren, M.R. Towler, S. Watts, R.G. Hill.** *21st European Conference on Biomaterials.* Sept 09th -12th, 2007. Brighton, UK.
- 45) Raman Spectroscopy of Keratin: A Comparison with other Methods of Evaluating Bone Health. **N.M. Cummins, M.R. Towler, A.W. Wren, N. Rushe, J. Saunders, P.M. Jakeman, P. Carroll, N. Murphy.** *21st European Conference on Biomaterials.* September 9 -12th, 2007. Brighton, UK.
- 46) Strontium Based Glass Polyalkenoate Cements for Skeletal Applications. **A.W. Wren, D. Boyd, M.R. Towler.** *20th European Conference on Biomaterials.* Sept 27th- Oct 1st, 2006. Nantes, France.
- 47) A Novel Screening Protocol for Osteoporosis? **M.R. Towler, A.W. Wren, P.M. Jakeman, N.M. Cummins.** *The 11th World Congress on the Menopause.* Oct 18-22nd, 2005. Buenos Aires, Argentina.

AWARDS AND AFFILIATIONS

- Received 1st Undergraduate Student Mentor Award at Alfred University, 2012.
- Received Training in FDA Regulatory Approval for 510k Submission.
- Patent Granted on Gallium-Silicate Glasses for Chemotherapeutic Applications, collaborating with Dr. Mark Towler (Alfred University, NY, USA), Dr. Matt Hall (Alfred, NY, USA) & Dr. Daniel Boyd (Dalhausie, NS, CA).
- Senior Safety Officer of High Temperature Lab at University of Limerick for 4 yrs.
- Professional Affiliations:
 - Member of the European Society of Biomaterials (ESB).
 - Member of the American Ceramics Society (ACerS).
 - Member of the Society of Biomaterials (SOB).
 - American Society for Engineering Education (ASEE).

Publications Pending

- 1) Characterization of Y₂O₃ and CeO₂ doped SiO₂-SrO-Na₂O Bioactive Glasses. **L.M. Placek, T.J. Keenan, F. Laffir, A. Coughlan, A.W. Wren.** Submitted Manuscript.
- 2) Synthesis, Characterization and in vitro cytocompatibility of Ga-bioactive glass/polymeric hydrogel composites. **T.J. Keenan, L.M. Placek, N.L. Keenan, M.M. Hall, A.W. Wren.** *Journal of Macromolecular Biosciences.* Submitted Manuscript.
- 3) Structural analysis of tantalum alkali-silicate glasses. A. Alhalawani, **D. Curran, T.J. Keenan, A.W. Wren, D. Boyd, M.R. Towler.** *International Journal of Applied Glass Science.* Submitted Manuscript.
- 4) Anti-bacterial and Anti-fungal Potential of Ga-Bioactive Glass and Ga-Bioactive Glass/Polymeric Hydrogel Composites. **L. M. Placek, T.J. Keenan, M.M. Hall, A.W. Wren.** Submitted Manuscript.
- 5) Characterization of Silica-based and Borate-based, Titanium-containing Bioactive Glasses for Coating Metallic Implants. **D.J. Curran, M. Papini, L.M. Placek, A.W. Wren, E.H. Schemitsch, P. Zalzal, M.R. Towler.** *Journal of Non-Crystalline Solids.* Submitted Manuscript.
- 6) The influence of increasing Sr²⁺ content on the structure of bioactive borate glasses. **Y. Li, D.J. Curran, E. Schemitsch, P. Zalzal, M. Papini, A.W. Wren, M.R. Towler.** *Journal of Non-Crystalline Solids.* Submitted Manuscript.