SIMON HAWARD – curriculum vitae

born 13 April 1974

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Academic Career

Postdoctoral Research Associate (appointed June 2010) Dept. of Mechanical Engineering, MIT (USA)

PI: Prof. Gareth McKinley

- Senior investigator on NASA-funded non-Newtonian fluid dynamics project
- Studied the shear and extensional rheology of industrially relevant particle filled viscoelastic fluids in a NASA glove-box experiment on the International Space Station (ISS)
- Used cross-slot stagnation point flow to study extensional rheology and elastic instabilities in wormlike micellar and associative polymer solutions
- Collaborated with partners from the University of Bristol using filament stretching rheometry to relate the fluid extensional properties to the spinnability of novel cellulose/ionic liquid suspensions used for spinning high-modulus fibres
- Supervised project students from Tufts University, Boston, MA, on implementation of a closed-loop feedback system for advanced filament stretching rheometry with controlled filament-thinning dynamics
- Collaborated with partners from the University of Porto on validating a numericallyoptimized microfluidic cross-slot for extensional rheometry of complex fluids
- Initiated collaboration with Profs M. Rubner and R. Cohen (both MIT) to characterize the dynamics of non-Newtonian flows through carbon nanotube forests

Postdoctoral Research Associate (April 2007- April 2010)

Dept. of Physics Nanoscience and Soft Matter Group, Bristol University (UK) *Pl: Dr. Jeff Odell*

- Collaborated closely with Dr. X-F Yuan's group at Manchester Interdisciplinary Biocentre (MIB) using micro-particle image velocimetry (micro-PIV) to study flow kinematics in microfluidic devices
- Developed the Extensional Flow Oscillatory Rheometer into a powerful and user friendly instrument for characterizing non-Newtonian fluids
- Used flow-induced birefringence measurements combined with (micro-PIV) and shear and extensional rheology to study a range of complex fluids in microfluidic flow geometries
- Experimentally measured the transient and steady state behaviour of birefringent polymer solution elastic stands in extensional flow
- Demonstrated massive flow modification effects and coil-stretch hysteresis even in highly dilute solutions of flexible polymers in stagnation point flow
- Published the first detailed measurements of flow-induced birefringence on a polymer solution in a microfluidic contraction geometry
- Initiated collaboration with partners from Bristol Royal Infirmary Mucin Research Group, resulting in the first opto-rheometrical study of the extensional flow of human saliva
- Initiated collaboration with partners from Bristol University Aerospace Engineering to study the stagnation point flow of novel bio-polymer/ionic liquid solutions used for fibre-spinning

Postdoctoral Research Associate (May 2003 – April 2007) Dept. of Physics Nanoscience and Soft Matter Group, Bristol University

PI's: Prof. Mervyn Miles & Dr. Terry McMaster

- Performed *in-situ* real-time atomic force microscopy (AFM) imaging of the adsorption of proteins to hydrophilic and hydrophobic surfaces
- Used AFM imaging to determine adsorption rates and understand the relative importance of protein-protein and protein-interfacial interactions
- Developed a temperature control system for the imaging environment of a commercial AFM fluid cell
- Performed single molecule force spectroscopy experiments on elastic peptides over a range of temperature, demonstrating thermal softening of the molecules
- Studied the real-time dissolution of biotite under the action of organic acids over a range of temperature to determine the dissolution rate and activation energy
- Used AFM to image live mycorhizal fungal hyphae growing on mineral surfaces and to map hydrophilic and hydrophobic domains on the hyphae

Ph.D Student, EPSRC studentship (1998-2002) Dept. of Physics, University of Bristol Dept. of Chemical Engineering, Simon Bolivar University (Venezuela) Advisors: Dr. Jeff Odell and Prof Alejandro Muller Thesis on 'Non-Newtonian flows of polymer solutions around spheres and through porous media'

Undergraduate Student (1994-1998) Department of Physics, University of Bristol M.Sci Physics, First-class Honours

Thesis on 'Falling balls in polymer solutions'

Teaching/Advising Experience

Massachusetts Institute of Technology:

- Lab professor for course 2.671 "Measurement and Instrumentation". Supervising a group of 14 undergraduate students on a hands-on lab-based mechanical engineering course. Spring 2012
- Co-supervised a group of three final year undergraduate students from Tufts University on implementing control hardware and software for the real-time closed-loop control of filament thinning dynamics in a filament stretching rheometer (spring 2011). This subsequently developed into a 2011 summer project
- Mentoring various post-graduate members and visiting students of the non-Newtonian fluids group in the Hatsopoulos Microfluids Laboratory, MIT

University of Bristol:

- Final year M.Sci and B.Sc project supervisor, 2009-2010
 The M.Sci project won the departmental award for the best undergraduate project for the 2009-2010 academic year and resulted in a substantial peer-reviewed article in the Journal of Non-Newtonian Fluid Mechanics (publication number 10, in the list below).
- Undergraduate tutor, Physics 1E course, 2005-2010
- Undergraduate laboratory demonstrator, 1998-2002

Professional Services

- **Manuscript reviewing:** Journal of Non-Newtonian Fluid Mechanics, Langmuir, Journal of Chemical Engineering, Analytical Chemistry, Journal of Rheology, Soft Matter, Oil and Gas Science and Technology
- Environmental health and safety coordinator: Hatsopoulos Microfluids Laboratory, MIT
- Session chair: "Non-Newtonian flows and stability" session, 83rd Society of Rheology meeting, Cleveland, OH, 2011

Society Memberships

The Institute of Physics, The British Society of Rheology, The Biophysical Society, The Society of Rheology

Grants and Awards

• Marie Curie International Incoming Fellowship, 2012-2014, \$208,672.40EU.

Publications

Peer-reviewed articles in international journals:

- SJ Haward, V Sharma, CP Butts, GH McKinley, SS Rahatekar (2012) Shear and extensional rheology of cellulose/ionic liquid solutions. *Biomacromolecules*, dx.doi.org/10.1021/bm300407q.
- 2. **SJ Haward**, GH McKinley (2012) Stagnation point flow of wormlike micellar solutions in a microfluidic cross-slot device: Effects of surfactant concentration and ionic environment . *Physical Review E*, **85**: 031502.
- 3. **SJ Haward**, TJ Ober, MSN Oliveira, MA Alves, GH McKinley (2012) Extensional rheology and elastic instabilities of a wormlike micellar solution in a microfluidic cross-slot device. *Soft Matter*, **8**: 536-555.
- 4. **SJ Haward**, JA Odell, M Berry, T Hall (2011) Extensional rheology of human saliva. *Rheologica Acta*, **50**: 869-879.
- 5. **SJ Haward**, V Sharma, JA Odell (2011) An extensional opto-rheometer for biofluids and ultra-dilute polymer solutions. *Soft Matter*, **7**: 9908-9921. *Soft Matter 'Hot Article' for August 2011 and selected as outside front-cover featured article.*
- 6. **SJ Haward**, MM Smits, KV Ragnarsdottir, JR Leake, SA Banwart, TJ McMaster (2011) In situ atomic force microscopy measurements of biotite basal plane reactivity in the presence of oxalic acid. *Geochimica et Cosmochimica Acta*, **75**: 6870-6881.
- 7. Z Li, X-F Yuan, **SJ Haward**, JA Odell, S Yeates (2011) Non-linear dynamics of semi-dilute polymer solutions in microfluidics: A study of a benchmark flow problem. *J Non-Newtonian Fluid Mechanics* **166**: 951-963.
- 8. Z Li, X-F Yuan, **SJ Haward**, JA Odell, S Yeates (2011) Non-linear dynamics of semi-dilute polymer solutions in microfluidics: Effects of flow geometry. *Rheologica Acta* **50**: 277-290.
- SJ Haward, PR Shewry, J Marsh, MJ Miles, TJ McMaster (2011) Force spectroscopy of an elastic peptide: effect of D₂O and temperature on persistence length. *Microscopy Research and Technique* 74: 170-176.
- 10. **SJ Haward** (2010) Buckling instabilities in dilute polymer solution elastic strands. *Rheologica Acta* **49**: 1219-1225.

- 11. **SJ Haward**, Z Li, D Lighter, B Thomas, JA Odell, X-F Yuan (2010) Flow of dilute to semidilute polystyrene solutions through a benchmark 8:1 planar abrupt micro-contraction. *J Non-Newtonian Fluid Mechanics* **165**: 1654-1669.
- 12. **SJ Haward**, JA Odell, Z Li, X-F Yuan (2010) The rheology of polymer solution elastic strands in extensional flow. *Rheologica Acta* **49**: 781-788.
- 13. **SJ Haward**, JA Odell, Z Li, X-F Yuan (2010) Extensional rheology of dilute polymer solutions in oscillatory cross-slot flow: the transient behaviour of birefringent strands. *Rheologica Acta* **49**: 633-645.
- 14. **SJ Haward**, PR Shewry, MJ Miles, TJ McMaster (2010) Direct real-time imaging of protein adsorption onto hydrophilic and hydrophobic surfaces. *Biopolymers* **93**: 74-84.
- 15. MM Smits, S Bonneville, **S Haward**, JR Leake (2008) Ectomycorrhizal weathering, a matter of scale? *Mineralogical Magazine* **72**: 131-134.
- TJ McMaster, MM Smits, SJ Haward, JR Leake, S Banwart, KV Ragnarsdottir (2008) High resolution imaging of biotite dissolution and measurement of activation energy. *Mineralogical Magazine* 72: 115-120.
- 17. JA Odell, **SJ Haward** (2008) Viscosity enhancement in the flow of hydrolysed poly(acrylamide) saline solutions around spheres: Implications for enhanced oil recovery. *Rheologica Acta* **47**: 129-137.
- JA Odell, SJ Haward (2006) Viscosity enhancement in non-Newtonian flow of dilute aqueous polymer solutions through crystallographic and random porous media. *Rheologica Acta* 45: 853-863.
- 19. **SJ Haward**, JA Odell (2004) Molecular orientation in non-Newtonian flow of dilute polymer solutions around spheres. *Rheologica Acta* **43**: 350-363.
- 20. **SJ Haward**, JA Odell (2003) Viscosity enhancement in non-Newtonian flow of dilute polymer solutions through crystallographic porous media. *Rheologica Acta* **42**: 516-526.

Submitted and in preparation:

- 1. **SJ Haward**, MSN Oliveira, GH McKinley, MA Alves (2012) An optimized cross-slot flow geometry for microfluidic extensional rheometry. Submitted to *Physical Review Letters*.
- 2. **SJ Haward**, A Jaishankar, MSN Oliveira, GH McKinley, MA Alves (2012) Extensional rheometry of hyaluronic acid solutions in an optimized microfluidic cross-slot geometry. In preparation.
- 3. V Sharma, **SJ Haward**, B Keshavarz, JG Serdy, A Suderland, P Threlffall-Holmes, GH McKinley (2012)Tethered cellulose ethers II: Extensional rheology of Ethyl Hydroxyethyl Cellulose (EHEC) and hydrophobically modified analogues (HMEHEC). In preparation.
- 4. MSN Oliveira, **SJ Haward**, GH McKinley, MA Alves (2012) Numerical simulation of purely elastic flow instabilities of a wormlike micellar solution in a microfluidic cross-slot. In preparation.
- 5. **SJ Haward**, M Kelly, T Lannin, GH McKinley (2012) Real-time closed-loop filament stretching extensional rheometry. In preparation.

Non-peer-reviewed conference proceedings:

 X-F Yuan, J Odell, Z Li, A Lanzaro, S Omowunmi, S Haward, S Yeates, C Booth, A Kamp (2008) Quantitative characterization of complex fluids in microfluidics. The XV International Congress on Rheology: The Society of Rheology 80th Annual Meeting, Monterey (California), *AIP Conference Proceedings* 1027: 252-254. **Journal Covers:**

- 1. SJ Haward, JA Odell (2010) Rheology Bulletin 51 (1).
- 2. SJ Haward, V Sharma, JA Odell (2011) Soft Matter 7: 9769-9769.

Presentations

Invited talks

- 1. Polymer solution characterization in stagnation point extensional flow. Program in Polymer Science and Technology (PPST) mini-symposium, MIT, USA (2012)
- 2. *Extensional rheo-optics of complex fluids in a microfluidic cross-slot device.* Biophysical Sciences Institute Christmas seminar, Durham University, Durham, UK (2011)
- 3. *Quantitative measurements on single molecules using scanning probe techniques.* Technical University of Malaysia, Department of Mechanical Engineering, Melaka, Malaysia (2005)
- 4. *Real-time interfacial observations and manipulations of biomolecules using AFM and single molecule force spectroscopy*. British Council International Networking for Young Scientists, Kuala Lumpur, Malaysia (2005)
- 5. *In-situ adsorption of proteins to mica and graphite surfaces using AFM.* British Council International Networking for Young Scientists, Vilnius, Lithuania (2004)

Conference talks

- 1. *Extensional flow of wormlike micellar solutions in a microfluidic cross-slot device.* BSR midwinter meeting, London, UK (2011)
- 2. Extensional flow of wormlike micellar solutions in a microfluidic cross-slot device. 83rd SOR annual conference, Cleveland, OH (2011)
- 3. Oscillatory extensional rheometry with bio-polymer solutions. AERC annual conference, Suzdal, Russia (2011)
- 4. *Extensional flow of wormlike micellar solutions in a microfluidic cross-slot device*. AERC annual conference, Suzdal, Russia (2011)
- 5. *The life cycle of birefringent strands and rheological consequences.* BSR midwinter meeting, Edinburgh, UK (2009) BSR Annual Award Lecture by J Odell
- 6. *Extensional rheology of polymer solutions in oscillatory micro-cross-slot flow*. AERC Conference, Cardiff, UK (2009)
- 7. *Extensional rheology of poly(ethylene oxide) solutions in oscillatory micro-cross-slot flow.* BSR midwinter meeting, Leeds, UK (2008)
- 8. *Quantitative characterization of complex fluids in microfluidics.* Society of Rheology Annual Meeting, Monterey, California, USA (2008) Presentation by X-F Yuan
- 9. The apparent activation energy for biotite dissolution by in situ atomic force microscopy (AFM) observations. Goldschmidt conference, Cologne, Germany (2007) Presentation by KV Ragnarsdottir
- 10. Force spectroscopy of repetitive peptides based on wheat HMW subunits. UK SPM, Warwick, UK (2005)
- 11. Direct, real-time imaging of protein adsorption using AFM. EMBO/FEBS workshop 'AFM Applications in Biology', Oeiras, Portugal (2004)

Conference posters

- 1. Shear and extensional rheology of cellulose/ionic liquid solutions. BSR midwinter meeting, London, UK (2011)
- 2. *Extensional opto-rheometry with biofluids and ultra-dilute polymer solutions*. BSR midwinter meeting, London, UK (2011)

- 3. *Elastic instabilities in flows of wormlike micelles.* Nonlinear Dynamics and Fluid Instabilities in the 21st Century, Haverford, Pensylvania, USA (2011)
- 4. *Shear and extensional rheology of particle-filled Boger fluids.* AERC annual conference, Suzdal, Russia (2011) Poster
- 5. Stagnation point extensional flow of a viscoelastic micellar solution in a microfluidic crossslot device. Program in Polymer Science and Technology, MIT, USA (2011)
- 6. *Extensional rheology of bio-polymer solutions in oscillatory cross-slot flow.* AERC annual conference, Goteborg, Sweden (2010)
- 7. *Extensional flow oscillatory rheometry of biopolymer solutions.* BSR midwinter meeting, Edinburgh, UK (2009)
- 8. *The transient behaviour of dilute polymer solution elastic strands.* Physical Aspects of Polymer Science Biennial conference, Bristol, UK (2009)
- 9. Variable temperature single molecule force spectroscopy in D₂O. Biophysical Society Annual Conference, Baltimore, Maryland, USA (2007)
- 10. Force spectroscopy of repetitive peptides derived from wheat HMW subunits. Biophysical Society Annual Conference, Salt Lake City, Utah, USA (2006)
- 11. *Direct, real-time imaging of protein adsorption using AFM.* EMBO/FEBS AFM Applications in Biology workshop, Oeiras, Portugal (2004)
- 12. Direct, real-time imaging of protein adsorption onto hydrophilic and hydrophobic surfaces. UK SPM, Nottingham, UK (2004)
- 13. *The flow of polymer solutions around spheres.* Physical Aspects of Polymer Science Biennial conference, Cambridge, UK (2001)
- 14. *The flow of polymer solutions around balls*. Physical Aspects of Polymer Science Biennial conference, Sheffield, UK (1999)