

ELECTRON MICROSCOPE UNIT  
ANNUAL REPORT  
2008

Permanent Staff

Director	B.T. Sewell	
Principal Technical Officer (Part Time)		J. Duncan
Chief Technical Officer	M. Jaffer	
Chief Scientific Officer	B. Weber	
Chief Technical Officer	M. Waldron	
Technical Assistant	S. Karriem	

Temporary Staff

Lecturer in Structural Biology	A Varsani
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HIGHLIGHTS OF 2008

NEW FEGTEM OPERATIONAL

Opening ceremony day, visit by Felix de Haas and Richard Henderson

APPLICATION FOR FEGSEM

To the NRF, support by Mat Eng and Chem Eng. didn't get the money

MSSA2008 IN BOTSWANA

Attended by Jason, Joni, Jeremy, Ndoria, Serah, Miranda. Trevor learnt to sing YMCA

UPS INSTALLED IN R. W. JAMES BUILDING

Installed wiring and UPS but not fully functional until 2009

BRANDON HAD A BABY

Yippeeeee

EMU REVIEW

ARVIND LEFT

USER MEETINGS

The series of user meetings initiated in 2006 continued throughout 2008: A user is invited to present their work which is then discussed by the other users present and the EM staff. The focus is on discussion which will enable the Unit staff to understand the needs of the user and the user to understand how best to use the capabilities of the Unit to solve their problems. Nine meetings were held in 2008 and a register of attendance maintained.

MEETING OF THE ELECTRON MICROSCOPE UNIT ADVISORY BOARD

A meeting of the EMU Committee was held on 11th August, 2008. The meeting was attended by Prof. D Visser, Prof. K Driver, Prof. S Kidson, Prof. R Knutsen, Prof. C Lang, A/Prof. BT Sewell, Prof. R Tait, Ms C McBride, Ms G Schirge and Ms M Waldron. The committee discussed and approved the 2007 annual report. Issues such as the upcoming EMU review, application to the NRF for a new FEGSEM and ending of the taught Masters in Structural Biology were discussed.

MAJOR EQUIPMENT PURCHASES IN 2008

Upgrade of TEM holders  
Gilson pump  
Apertures  
Repair of Proscan camera  
Repair of ion pump for Leo912  
Power supply for Leo912  
Leaf scanner  
Display screen Leo912  
Varion ion pump S440

#### USE OF THE UNIT

Services provided by the Unit during 2008 are listed in Table 1. Frequent usage was made of all key services of the Unit. 209 people made use of the microscopy services of the Electron Microscope Unit in 2008, this is an increase from 2007, back to a similar number of users experienced in 2006. Seventeen further users utilized services other than those related to microscopy, notably critical point drying and liquid nitrogen collection. The names and departments of the users are listed in Table 2.

Total time spent using the Unit's microscopes was 1374 hours in 2008 which was slightly higher than the microscope hours in 2007 (Fig.). In the past, the use of the S200 SEM for EBSD work has increased the microscope usage figures dramatically (as seen in Fig.2, in 2000, 2001, 2003 and 2005). This microscope was not used at all for EBSD in 2008 so the figures are not influenced by this and the reason for an increase in total hours from 2007 is a combination of more users and the new F20 TEM becoming operational in 2008.

Fig 3 shows the top 20 departments, institutes and companies who used the electron microscopes during 2008. The Structural Biology group used the instruments for 366 hours, the next department being Chemical Engineering with 154 hours, through to Geological Sciences, using the instruments for 11.5 hours.

## ELECTRON MICROSCOPES AND ASSOCIATED EQUIPMENT LEO STEREOSCAN S440 SEM

The S440 was used for a total of 505 hours which is a decrease on the usage in 2007. Fig. 4 shows the hours the instrument was used since its installation in 1994. The highest years of use were 1995, the first full year it was operating, and 2001 which coincided with a change in user pattern from a few users with high hours on the instrument to more users (actually, this was also the year Dane left - not sure if this is significant!), each wanting to operate the microscope for less time. 67 people from UCT made use of the instrument in 2008 and there were 59 outside users. Although the number of hours the instrument was used was less than last year, the number of users increased. The instrument was down for 7 days during 2008, as a result of power cuts. Unfortunately, also as a result of power cuts, the hard drive on the EDS computer was destroyed in February. Due to difficulties with data recovery and software installation, the EDS was not operational again until June.

## CAMBRIDGE S200 SEM

The S200 was only used for 2 hours in March by one student from Materials Engineering, Fig.6 shows the use of this instrument since 1990, the peak in 2000 coincides with the installation of the EBSD equipment. The drop in use of the EBSD is mainly due to the installation of a new FEGSEM at CSIR, Pretoria which has a faster, higher resolution EBSD system than the one available at the EMU. Although the S200 microscope is now hardly used, it is still essential to maintain it as a back-up instrument if the S440 is down for any length of time. Fortunately, the S440 has proved to be a reliable machine and has only been down for short periods over the last few years.

## JEOL 1200EX TEM

The Jeol 1200EX was fully operational all year and was used for a total of 391 hours, the most it has been used since its installation in 2002 (Fig.7). As well as being used by the Structural Biology students who utilised the cryo facilities on the equipment, the TEM turned out to be a vital back-up for the Leo912 TEM which was down for long periods during the middle of 2008 - shown by the corresponding peak in the Jeol 1200EX hours of use ( Fig.8). 37 people from UCT with another 27 from other universities or institutes used the 1200EX TEM in 2008

## LEO 912 TEM

The Leo 912 was badly affected by the power cuts during 2008 and was used for the lowest number of hours since its installation in 2003 (Fig.9). The TEM was down for 5 months between May and October (Fig.10) and again for most of November. Parts of the machine that were damaged by the power cuts were the ion pump, screen, camera and power supply. It was used for a total of 189 hours by 35 people from UCT and 25 outside users.

## ULTRAMICROTOME

Use of the ultramicrotome in 2008 was 280 hours, a slight decrease from last year. Cryomicrotome facilities were used by

### LIGHT MICROSCOPY

All the light microscopes and Zeiss Axiocam continued to be used throughout the year, by a variety of students. The cathodoluminescence equipment designed to be used with the M400 light microscope proved to be popular with two geology students. Four students from Pinelands High school used the M400 after hours for a school project.

### IMAGING CENTRE

The imaging centre has sophisticated software capability aimed at image enhancement and three dimensional reconstruction. Photographic negative digitization using the Nikon LS4500 and Leafscan scanners is the basis of data analysis and a second Leaf scanner was acquired at the end of the year. It is hoped that this will alleviate the backlog of negatives that need scanning that occasionally occurs during busy periods.

## TEACHING AND EXTENSION

### INDIVIDUAL TRAINING

Leo 912 TEM

Jeol 1200EX TEM

Leo S440 SEM

David Britton, Physics

Dave Unugibe, Physics

Michel Nzikou, Physics

Joseph Sithole Ithemba

Lester Chihoro, CME

Leon Duffi, University of the Ivory Coast

Kerstan Drost, Geological Sciences  
Schadrack Nsengiyumva, Physics  
Katherine de Villiers, Chemistry

Ultramicrotome

#### SCHOOL VISITS

The following schools brought students to visit the Electron Microscope Unit  
Bishops High School, 4 A level students  
Herschel High School, 30 grade 11 students  
Reddam High school, 3 A Level students  
Springfield Convent, 1 work shadow  
Bergvliet High School, 1 work shadow  
Pinelands High School, grade 11 project

#### MICROSCOPY FOR BIOLOGISTS

The Microscopy for Biologists course was held in March and attended by 28 MCB honours students.

Structural Biology Msc Students

#### RESEARCH ACTIVITY

Research was generally carried out in collaboration with other departments and laboratories. The following projects which depend on the initiatives of Unit members were active during 2008:

Chromatin

T. Frouws, B.T. Sewell, H.-G. Patterson

Glutamine synthetase

J. van Rooyen, B.T. Sewell, V.R. Abratt

3D reconstructions from metal coated objects

J.D. Woodward, B.T. Sewell

Angiotensin converting enzyme

J. Watermeyer, I. Chitapi, B.T. Sewell, E. Sturrock

Nitrile hydratases

T. Tsekoa, B.T. Sewell, O.T. Bishop, M. F.-R. Sayed, D.A. Cowan

The amidase from *Geobacillus pallidus*

S.W. Kimani, B.T. Sewell, M.F.-R. Sayed, D.A. Cowan

Structure of the nitrilase from *Bacillus pumilus*, *Pseudomonas stutzeri* and *Gloeocercospora sorghi*

B.T. Sewell, B. Weber, N. Thuku

The cyanide degrading enzymes are of potential industrial significance. We have solved three structures at varying resolutions by single particle techniques and made substantial progress on the structure of the pH 5.4 fibrous form of the cyanide dihydratase from *B. pumilus*. Progress was made towards the creation of an atomic model on the basis of homology with two known structures.

#### PUBLICATIONS

Publications for 2008, that resulted from research in which the EM Unit staff have been directly involved are listed:-

Varsani was a publishing machine!!!

Basile, L.J., Willson, R.C. Sewell, B.T., Benedik, M.J. (2008) Genome mining of cyanide degrading

nitrilases from filamentous fungi, *Applied Microbiology and Biotechnology*, 80, 427-435

Castillo-Urquiza, G.P., Beserra, J.E.A, Bruckner, F.P., Lima, A.T.M., Varsani, A., Alfenas-Zerbini, P & Zerbini, F.M., 2008. Novel begomoviruses infecting tomato and associated weeds in Southeastern Brazil. *Arch Virol.*;153,1985-9

Oluwafemi, S., Varsani, A., Monjane, A.L., Shepherd, D.N., Owor, B., Rybicki, E.P & Martin, D.P. 2008. A new African streak virus species from Nigeria. *Arch Virol.* 153, 1407-10

Shepherd, D.N., Varsani, A, Windram, O., Lefeuvre, P., Monjane, A.L., Owor, B., & Martin.D.P. 2008 A. Novel Sugarcane streak virus and Sugarcane streak Reunion virus mastrevirus isolates from Southern Africa and La Reunion. *Arch Virol.* 153, 605-9.

Shepherd, D.N., Martin, D.P., Lefeuvre, P., Monjane, A.L., Owor, B., Rybicki, E.P. & Varsani, A. 2008. A protocol for the rapid isolation of full geminivirus genomes from dried plant tissue. *J Virol Methods.* 149, 97-102

Thuku, R.N., Brady, D., Benedik, M.J., Sewell, B.T. (2008) Microbial nitrilases: versatile, spiral forming, industrial enzymes, *Journal of Applied Microbiology* Epub ahead of print doi:10.1111/j.1365-2672.2008.03941.x

Waldron, H.N., Wainman, C.K., Waldron, M.E., Whittle, C and Brundrit, G.B. 2008. A prominent colour front in False Bay, South Africa: Cross-frontal structure, composition and origin. *Estuarine, coastal and Shelf Science*, 29 1-9

Watermeyer JM, Kröger WL, O'Neill HG, Sewell BT, Sturrock ED. (2008) Probing the basis of domain-dependent inhibition using novel ketone inhibitors of Angiotensin-converting enzyme. *Biochemistry*, 47, 5942-5950

Windram, O.P., Weber, B., Jaffer, M., Rybicki, E.P. Shepherd D.N., & Varsani, A. 2008., An investigation into the use of Human papillomavirus type 16 virus like particles as a delivery vector system for foreign proteins: N – and C termini fusion of GFP to the L1 and L2 capsid proteins. *Arch Virol.* 153, 585-9.

Woodward, J.D., Weber, B.W., Scheffer, M.P., Benedik, M.J., Hoenger, A., Sewell, B.T. 2008. Helical Structure of Unidirectionally Shadowed Fibres of Cyanide Hydratase from *Gloeocercospora sorghi*. *Journal of Structural Biology.* 161(2) 111-119.

van Antwerpen, T., McFarlane, S.S., Buchanan, G.F., Shepherd, D.N., Martin, D.P., Rybicki, E.P. & Varsani, A. 2008., First report of maize streak virus infection of sugarcane in South Africa. *Plant Disease* 92, 982

van der Walt, E., Martin, D.P., Varsani, A., Ploston, J.E., & Rybicki, E.P., 2008. Experimental observations of rapid Maize streak virus evolution reveal a strand-specific nucleotide substitution bias. *Virology Journal* 5:104 (24 September 2008)

Varsani, A., Oluwafemi, S, Shepherd, D.N., Monjane, A.L., Owor, B., Windram, O., Rybicki, E.P., Lefeuvre, P. & Martin, D.P. 2008. Panicum streak virus diversity is similar to that observed for Maize streak virus. *Arch Virol.* 153, 585-9.

Varsani, A., Shepherd, D.N., Monjane, A.L., Owor, B.E., Erdmann, J.B., Rybicki, E.P., Peterschmitt, M., Briddon, R.W., Markham, P.G., Oluwafemi, S., Windram, O.P, Lefeuvre, P., Lett,

J-M. & Martin, D.P., 2008. Recombination, decreased host specificity and increased motility may have driven the emergence of Maize streak virus as an agricultural pathogen. *J Gen Virol.* 89, 2063 - 2074

#### Publications by Users of the Unit

The following list includes those papers given to the Unit by users. It is unfortunately not a complete list of published work that has been conducted in the Unit. A great deal of the work done by users is published only as conference proceedings, such work is not reflected here.

Cassanueva, A, Paul, L, Patrick, S & Abratt, V. 2008. An AraC/XylS family transcriptional regulator homologue from *Bacteroides fragilis* is associated with cell survival following DNA damage. *Fems Microbiology Letters.* 278 (2) 249-256

De Villiers, K, Egan, T & Marques, H. 2008. The crystal structure of halofantrine-ferriprotoporphyin IX and the mechanism of action of arylmethanol antimalarials. *Journal of Inorganic Biochemistry* 102. 1660-1667

Egan, T 2008. Haemozoin formation. *Molecular and Biochemical Parasitology* 157. 127-136

Egan, T 2008. Recent advances in understanding the mechanism of hemozoin (malaria pigment) formation. *Journal of Inorganic Biochemistry* 102. 1288-1299

Halsey, R et al. 2008. Chimaeric HIV-1 subtype C Gag molecules with large in-frame C-terminal polypeptide fusions form virus-like particles. *Virus Research* 133 (2) 259-268

Knutsen R.D. 2008. Analysis of microstructure evolution during Steckel mill rolling of AISI304 stainless steel *ISI International.* 48. 200-207

Langerman F. 2008. The knowledge chambers, an exhibition series. Bell-roberts Gallery, Cape Town and Artspace Gallery, Johannesburg

Lewis, C & Karageorgopoulos, P. 2008. A new species of *Marphysa* (Eunicidae) from the Western Cape of South Africa. *Journal of the Marnie Biological Association,* 88 (2) 277-287

Mayosi, B et al. 2008. Mortality on patients treated for tuberculosis pericarditis in sub-Saharan Africa. *SAMJ South African Medical Journal.* 98 (1) 36-40

Parker, S. 2008. Analysis of microstructure evolution during Steckel mill rolling of AISI304 stainless steel". *ISI International,* vol.48 (2).200-207

Sangermano M, N Lak, G Malucelli, A Samakande, RD Sanderson. 2008. UV-curing and characterization of polymer-clay nanocoatings by dispersion of acrylate-functionalized organoclays. *Progress in Organic Coatings* 61. 89-94.

Shaboodien, G. et al 2008. The prevalence of myocarditis in HIV-Associated cardiomyopathy in Cape Town *Cardiovascular Journal of Africa.* 19 (5) 32-40

Smythe, W.A., Joiner, K.A. and Hoppe, H.C. 2008. Actin is required for trafficking in the malaria parasite *Plasmodium falciparum*. *Cellular Microbiology* 10(2) 452-464

Spottiswoode, B et al. 2008. Abnormal diastolic and systolic septal motion following pericardiectomy demonstrated by cine DENSE MRI. *Cardiovascular Journal of Africa.* 19 (4) 208-



van den Dungen E.T.A., H Mathawa, JB McLeary, RD Sanderson, B Klumperman.2008. Initialization behavior at various target molecular weight RAFT-mediated methyl acrylate polymerizations. *Journal of Polymer Science, Part A: Polymer Chemistry* 46. 2500-2509

Welker, C., N. S. Phala, J. R. Moss, M. Claeys, E. van Steen. 2008. Theoretical feasibility of CO-activation and Fischer–Tropsch chain growth on mono- and diatomic Ru complexes. *Journal of Molecular Catalysis A: Chemical*, 288(1-2). 75-82

#### PhD Theses

Botha, Subelia, UWC Chemistry. Synthesis and characterization of nanofluids for cooling applications

Gitari, Mugeru, UWC Chemistry. Evaluation of the leachate chemistry and contaminants attenuation in acid mine drainage by fly ash and its derivatives.

Minani, Evariste, CME. Microstructure, stress and defect evolution under illumination in hydrogenated amorphous silicon (Si:H)

Owor, Betty, MCB. Maize streak virus (MSV) diversity in Uganda and the assessment of gene slicing as a tool for development of resistance to MSV.

Shaboodien, Gasnat. Medicine. The pathogenesis of HIV-associated cardiomyopathy: a histological, virological and genetic study.

Van der Walt, Eric, MCB. An experimental investigation of the mastrevirus evolution

Watermeyer, Jean, MCB. Structural determinants of the domain-selectivity of novel inhibitors of human testis angiotensin-converting enzyme.

#### Msc Theses

Blignaut, Annelie, Chemical Engineering. Influence of basicity in Fischer-Tropsch synthesis over supported iron-based catalysts.

Bayley, Gareth. Inst Polymer Science. Synthesis and characterization of organic-inorganic hybrid block copolymers of polydimethylsiloxane and polystyrene.

Cain, Victoria. CME. Influence of grain size and niobium content on hot ferritic stainless steels

Hockman, Dorit. Zoology. Limbs gone batty: the role of the anterior-posterior patterning signal, Sonic Hedgehog, in the development of the unique bat limb.

Kamng'ona, Arox. MCB. The inhibition of M-MLV and HIV-1 reverse transcriptase by polyphenols extracted from the resurrection plant *Myrothamnus flabellifolia* (Welw.)

Ofosu, Osei. CME. A study of the feasibility of advanced hybrid thermoplastic composites for aerospace and automotive applications

Oguh, Jerry, CME. Microstructural modification of investment cast titanium alloy using hydrogen as a temporary alloying element..

Patterson, Veronica. Chemical Engineering. Chemistry activity and selectivity of transition metal

(Fe, Mo and Wo) carbides in the Fischer-Tropsch synthesis.

Soeyeh, Kim. CME. Kenaf fibre reinforced polypropylene

User Projects

#### FINANCE

Details of the Unit's accounts are presented in Table 3.

#### OTHER MATTERS

LEAVE BY THE DIRECTOR

#### SERVICE TO INDUSTRIAL AND OTHER EXTERNAL USERS

The Unit offers its facilities on an ad hoc basis to external users. Clients exploiting these services during 2008 were: Frkia Wigs, Huntsman Engineering, Johnson & Johnson, Metalquip, Metsep, Mintek, Namakwa Sands, NanoCl, One eighty Degrees, Origen, Patterson and Cooke, Plascon and Roedinger Agencies. These clients almost exclusively use the S440 SEM and the 912 TEM and together accounted for 86 hours instrument time.

#### VISITORS TO THE UNIT

#### SUMMARY

Prepared by: Associate Professor B.T. Sewell and Mrs. Miranda Waldron

#### TABLE 1

Services Offered by the Unit during 2007

#### Table 2

2008 User List

#### TABLE 3

E.M.U. Finances, 2008