RESEARCH REPORT

1. Name: Hamera Abbas （ID No.: SP05101 ）

2. Current affiliation: University of Glasgow.

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
XChemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University, Research Institute of Electronic Science.

5. Host researcher: Prof. Takayoshi Nakamura

6. Description of your current research

The self-assembly of metal-oxide building blocks to produce multi-functional materials is becoming a rapidly expanding area of research.[1] One potential route to the design of such materials uses polyoxometalate (POM) building blocks as synthons. The unique structural versatility and electronic properties of polyoxometalates mean that this class of materials may have application in molecular / nano-electronics in the development of functional materials. In this respect we have recently developed a novel synthetic approach that introduces bulky flexible organic cations that wrap around reactive POM intermediates and hence restrict their aggregation to more highly symmetrical clusters, allowing the isolation of a diverse set of new POM clusters and building blocks. This approach offers a systematic control over the self-assembly of POM systems and resulted in the synthesis of novel POM compounds that displayed e.g. unprecedented structural[2] or physical[3] features. The successful extension of this 'shrink-wrapping' strategy has led to the assembly of a diverse range of novel polymeric architectures[4] based on transferable silver-molybdenum POM-based building blocks along with the growth of conducting molecular wires.

The growth of the $\{Ag(Mo_8O_{26})Ag\}$ (**1**) building block into a one-dimensional polymer ($\{(Bu_4N)_2[Ag_2Mo_8O_{26}]\}_n$, **2**) is facilitated by the 'wrapping' action of the n-Bu_4N^+ organic counter ion and the formation of short Ag-Ag contacts of 2.853 Å (see Fig. 1). In the crystalline state this structure can be seen as rod-like polymers in the electron micrograph. Decomposition upon a scratched silicon surface initiates the radial growth of these polymers to form spheralite structures that extrude silver nano-fibres.

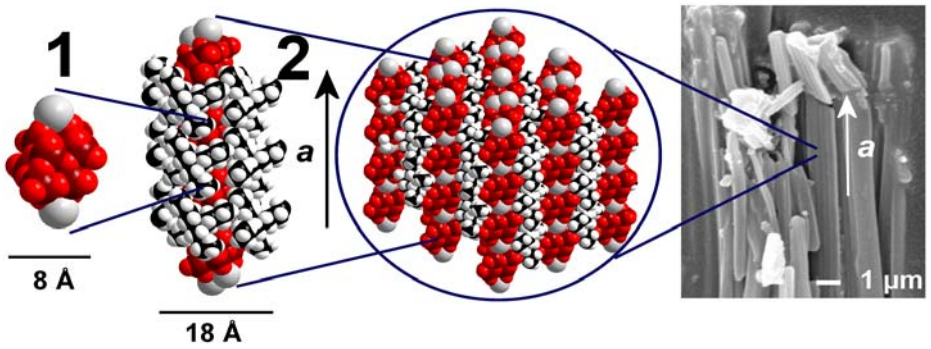

Figure 1. Space-filling representations of segments of the crystal structure showing molecular growth of a the {Ag(Mo_8O_{26})Ag} subunit (**1**) to the polymer (**2**) 'shrink-wrapped' by bulky organo-cations along with a Scanning Electron Micrograph (SEM) image of the micro crystals.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Electronic characterization of silver nano-wires by Atomic Force Microscopy (AFM).

Description of the research activities:

Our recent research into silver-molybdenum clusters is of particular interest as this material has the ability to grow metallic 'nano-wires' on this scale in complex arrangements, which is a prerequisite for functional nano-systems. The extrusion of 'Ag' wires from a crystal of POM array is unprecedented and for this reason offers new and exciting prospects in the field of nano-technology. Prof. Nakamura's research group is experienced in the area of understanding and manipulation of nano-wires. In addition to this knowledge the group have access to instrumentation that can probe chemical materials and gain insight into their properties.

My time in Japan was spent trying to locate the nano-wires and studying their morphology by AFM and if possible measure their conductivity. Training was given on how to use two different AFM instruments and on how to evaporate gold electrode necessary for electronic characterization of the wires. Various techniques were employed to grow the wires and then deposited onto either silicon or mica substrates. Gold electrodes were then evaporated onto the silicon substrates and the wires searched for along the 'edge' of the electrode. However imaging the wires proved difficult as the AFM could only cover a very small distance of 25 x 25µm and crystals on the substrate surface made it difficult to obtain images with good resolution. Equally difficult was locating wires that have grown or were positioned near the 'edge' of the electrode. In light of these difficulties some samples were sent to Kobe to be studied by SEM, where it was possible to cover a larger area of the substrate and obtain images of high resolution regardless of other materials on the surface. An additional feature of the SEM

instrument in Kobe is the inclusion of micro-contact probes that can measure the conductivity of selected nano-wires. As a result of this recent development my work will be ongoing and results achieved from these studies will be received in time. However initial observations indicate that acquiring the data for electronic characterization is possible and that the silver nano-wires are good conductors.

[1] D. E. Katsoulis, *Chem. Rev.* **1998**, *98*, 359.

[2] D. -L. Long, P. Kögerler, L. J. Farrugia, L. Cronin, *Angew. Chem. Int. Ed.* **2003**, *42*, 4180.

[3] D. –L. Long, P. Kögerler, L. Cronin, *Angew. Chem. Int. Ed.* **2004**, *43*, 1817.

[4] H. Abbas, A. L. Pickering, D.-L. Long, P. Kögerler, and L. Cronin,. *Chem. Eur. J.* **2005**, *11*, 1071.

8. Please add your comments (if any)

I consider myself to be very fortunate to have spent my two months with Prof. Nakamura and his group and I am grateful to them for all their help and discussions regarding my work. In addition I would also like to thank Prof. Nakamura for allowing me to attend the international LB11 conference on organized molecular films. It was a wonderful opportunity to meet people and be exposed to another area of materials science and which resulted in some very interesting discussions. In trying to measure the conductivity of the wires with AFM, I understand now more clearly the challenges in carrying out such work and hope to develop these problems in my future work along with the helpful suggestions of Prof. Nakamura and his group. My time in Japan has proven to be insightful into many aspects of Japanese research methods and lifestyle and in conclusion this research experience has been invaluable to my continued development as a scientist.

9. Advisor's remarks (if any):

Due to limitation of time the experiments could not be completed despite Ms. Abbas's efforts. We will continue the collaboration after the programme is finished, which will provide us with fruitful results on the POM-nanowire systems.

RESEARCH REPORT

1. Name: Miss Gemma Attrill （ID No.: SP05102）

2. Current affiliation: Mullard Space Science Laboratory, University College London.

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Solar Physics Group, University of Kyoto, Japan.

5. Host researcher: Professor K. Shibata

6. Description of your current research

I am a first year PhD student studying solar physics at the Mullard Space Science Laboratory, part of University College London. In particular I am studying the phenomenon known as coronal dimming – where regions of the solar atmosphere are suddenly evacuated of mass just prior to a huge explosion know as a coronal mass ejection.

Coronal mass ejections (CMEs) blast millions of tonnes of material into interplanetary space. This material is highly charged and can cause considerable disruption to communications and navigation technology if the explosion happens to be directed towards the Earth.

Coronal dimming has been firmly associated with CMEs for some years now and the race is on to improve our understanding of what triggers these potentially devastating solar explosions. With current spacecraft data, coronal dimming signatures are detectable up to thirty minutes before the main CME so careful study of the occurance and evolution of the dimming regions may yield helpful information in our quest to understand and ultimately to predict these violent solar storms.

It is especially important to understand the solar magnetic field as it is appears to be the main driving force behind most of the Sun`s activity.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Magnetic fields & intensity changes in solar coronal dimming regions.

Description of the research activities:

At Kyoto university I have been working at the Kwasan Solar Observatory. Here I have combined data from many different sources, including ground-based data, (such as H-Alpha data from Hida Solar Observatory located in the Japanese Alps) and space-based data from both the Solar and Heliospheric Orbiter (SoHO) spacecraft and the Japanese spacecraft Yohkoh. I have been studying an event that occurred on 10th April 2001 and using the multi-wavelength data I have shown that the dimming regions I have identified appear in several different wavelengths and are therefore not due to temperature variation but are indeed due to mass loss. By

studying the evolution of the extreme ultra violet emission from the dimming regions, I have found similar patterns between regions of different magnetic polarities. This suggests that these regions may be connected by magnetic loop systems, giving us important information on the magnetic structure of the eruptive region. I have also demonstrated that the evolution of the emission from the dimming regions can be used as a diagnostic tool to determine the timescale over which the magnetic reconnection process takes place. This is of great interest because magnetic reconnection is the mechanism which is believed to be responsible for the initiation of the violent explosions that manifest as CMEs.

8. Please add your comments (if any):

I have thoroughly enjoyed my time in Kyoto this summer – the city is simply amazing & it is very interesting to start to understand a little of the Japanese way of life. From the research point of view I cannot thank my supervisor and colleagues enough for their support, guidance and encouragement during my time at the Kwasan Observatory. I have learnt such a lot during my time here and hope very much to return again in the future – and to welcome them to England to build further collaborations which will undoubtedly strengthen the potential of the Japan-UK-US Solar-B spacecraft mission, due for launch next year. Thank you JSPS for this incredibly rewarding opportunity – both on a personal and professional level.

RESEARCH REPORT

1. Name: John Berrisford （ID No.: SP05103）

2. Current affiliation: University of Sheffield, UK.

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo University of Pharmacy and Life Science

5. Host researcher: Prof. A. Yamagishi

6. Description of your current research

My current research has been aimed at determining the structure and mechanism of the enzyme phosphoglucose isomerase from the hyperthermophilic archaea *Pyrococcus furiosus*. Phosphoglucose isomerase catalyses the reversible isomerisation of 6-phosphoglucose and 6-phosphofructose within the glycolytic pathway which is central to energy utilization within cells. Structural determination through X-ray crystallography revealed that the enzyme consists of a distinct fold from that of the eukaryotic counterparts. Further examination of the active site of the pyrococcal enzyme identified the presence of a metal ion which is absent in the eukaryal enzyme. Previous biochemical and structural studies on the eukaryotic enzyme had determined the mechanism used and the residues involved in the catalysis by this enzyme. Current biochemical and structural work on the pyroccocal enzyme is trying to establish whether or not a similar mechanism occurs to that of the eukaryotic enzyme despite the lack of sequential and structural similarity between the two types of phosphoglucose isomerase.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Site directed mutagenesis of *Thermoplasma acidophium mreB* gene.

Description of the research activities:

Within our cells, a protein named actin is responsible for maintaining the cell morphology. Our interest is in the evolutionary origin of actin within organisms which predate us (eukaryotes), namely archaea. To investigate this problem a

homologue of actin, MreB, was identified as being a candidate and has been cloned from an archaea, *Thermoplasma acidophilum.* The protein produced by this clone will be used in X-ray crystallographic studies to determine its structure, which will then be compared to eukaryotic actin. Unfortunately current attempts to crystallize the protein have failed, crystallization is a prerequisite to X-ray crystallographic studies.

To overcome this problem mutations in the *mreB* gene were made to change the amino acid residues predicted to be on the surface of the protein without effecting its overall structure. The surface residues are very important in providing protein-protein interactions during crystallization and some were therefore mutated to increase the number of interactions which are favorable to crystallization. Three mutated genes which encode the mutant proteins were produced and prepared for expression tests, during my summer stay in the laboratory. This work will be continued by another member of the laboratory in Japan.

8. Please add your comments (if any):

I would like to thank the JSPS for organizing a very well run and worthwhile exchange program that will hopefully produce many new international collaborations. It also provided an invaluable insight into science research and the culture within Japan. I will be recommending that others take part in this program upon my return to England.

9. Advisor's remarks (if any):

Mr. Berrisford has succeeded in making three mutant genes of an archaeal actin homologue MreB, during the short summer stay in the lab. These genes will be used to obtain mutant MreB proteins that are required for the crystallization analysis. He has also successfully gotten along with my lab members. The graduate students in my lab have absolutely enjoyed the friendship with him. I hope he has also enjoyed his stay in Japan and in my laboratory and that the experience will make his scientific career and future life fruitful.

RESEARCH REPORT

1. Name: Dane William Comerford （ID No.: SP05104）

2. Current affiliation: School of Chemistry, University of Bristol,
Bristol, BS8 1TS, United Kingdom

3. Research fields and specialties:
Humanities Social Sciences X Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Professor Masahiro Kawasaki

6. Description of your current research

Investigation of diamond growth environments by laser-based methods

Diamond is an exceptionally useful engineering material owing to its structural, electronic and thermal properties. I use the hot filament chemical vapour deposition (CVD) technique to grow diamond thin films from a mixture of methane and hydrogen gas. In the gas phase, I observe the concentrations of key radical species in order to develop a detailed kinetic model for CVD diamond growth.

Addition of a boron-containing precursor to the CVD admixture provides a route to the production of boron doped diamond films. Boron imparts p-type semiconductivity into the as-grown diamond and may be used in electrochemical sensors, thermal management devices, and when combined with a suitable n-type diamond semiconductor, a UV light source.

I use cavity ring-down (CRD) and resonance enhanced multiphoton ionization (REMPI) spectroscopy to investigate the role that boron atoms (and carbon radicals) have on this gas phase composition and ultimately, within the diamond itself.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Photodissociation of water ice films with ultraviolet (193 nm and 157 nm) laser light with atmospheric and astrophysical implications

Description of the research activities:

Oxidation of hydrocarbons at ground level and higher together with air travel, contribute significantly to the quantity of H_2O in the stratosphere. This rise appears to correlate with increased observation of noctilucent clouds (NLC), first observed (1885) in the years following the Krakatoa eruption, which injected an unusually large amount of water vapour into the atmosphere. These clouds of small (ca. 60 nm diameter) ice particles occupy a thin layer in the mesopause at altitudes of 80-85 km in the high latitude regions. Their number and frequency are rising, so it is vital that we fully understand the photochemistry of ice and its potential impact on the atmospheric cycles and subsequent feedback loops. In addition, thin water ice films are relevant to conditions present on icy outer Solar System bodies, because the surfaces of these objects are often coated with ice or frost.

Most of the literature do date focuses on the bombardment of water ices with ions to investigate the excitation and subsequent dissociation of the lattice to generate ions, radicals and stable molecules. Ion sputtering causes an 'electronic cascade', by which a single incident ion produces thousands of electronic excitations. Excited water molecules may then fragment to generate oxygen and hydrogen atoms, and molecules and combinations thereof. Use of a photon source precludes any significant heating of the sample, thus suppressing morphological or dynamical perturbations. Use of a laser, with a very narrow energy distribution, means that we may tailor the excitation of an ice surface to a particular electronic transition.

Previous work by this group has determined the following protocol for production of water ice films to a depth of around 6000 monolayers (ML): Amorphous solid water (ASW) films were prepared by molecular beam expansion deposition of H_20 (or D_20) at 85 K for one hour; Polycrystalline samples were prepared in the same way, but annealed at 130 K for 30 minutes.

In the experiments this summer, D_2O was used in addition to H_2O to help distinguish between background and isotope effects. This project is interested in looking at H

(or D) atoms produces as a result of photodissociation of ice films. A transition at 7.9 eV was identified to be independent of layer thickness, it is thus thought to be pertinent to surface water molecules and not associated with the bulk conditions. To understand the mechanism for H (or D) production from photodissociation of hydrogen-bonded solid water networks, ASW and polycrystalline ice made with H_20 and D_20 were photolysed above the reported dissociation threshold with 193 (6.4 eV) and 157 nm (7.9eV) radiation. H (or D) production was monitored with mass spectrometery.

Depending on the morphology, isotope used and the wavelength of the photodissociation laser, one, two of thee kinetic energy distributions were noted. These temporal peaks were caused by three very different mechanisms. A direct release of H (or D) from an exposed water molecule caused the fastest peak, the second is thought to come from a similar area, but is collisionally relaxed by the surface of the ice to give a slower peak. The third and slowest detected hydrogen atoms were only seen upon irradiation with 175 nm (corresponding to 7.9 eV) light and its origin is not yet known. Either dissociative recombination, or a different mode of production cause this peak, rather than further collisions.

8. Please add your comments (if any):

I have learnt some new experimental techniques this summer, that I will be able to use in future experiments, for example: vacuum ultraviolet (VUV) laser alignment and time of flight mass spectrometer (TOF MS) usage. The experimental work is planned for publication if Nature or The Journal of Physical Chemistry. I have made a few academic connections and some friends, while I have been in Kyoto.

RESEARCH REPORT

1. Name: Robert Dorner （ID No.: SP05105 ）

2. Current affiliation: Royal Institution of Great Britain

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Tatsuya Okubo

6. Description of your current research

Before coming to Japan I was working on microporous Aluminophosphates (AlPO) and aspects that influence the formation of these materials during synthesis. A structure directing agent (SDA) is always needed to form a porous material. Different AlPOs can be formed by the same SDA, and one AlPO structure can be formed by several different SDAs. It is hence of great interest to come to a better understanding of the role these SDAs play during synthesis. One specific system was chosen (AlPO-5, synthesized using N-methyldicyclohexylamine as SDA) and by combining experimental and computational techniques it was possible to locate the template in the microporous framework. The template was located experimentally by High Resolution Powder X-Ray Diffraction. The experimental data were then supported by a theoretical approach, using Monte Carlo Docking Calculations, which delivered a very similar picture to the experimentally obtained one. The research showed, that the template displayed long range disorder within the channel system of the AlPO, as the template can be seen as two up-right, rigid benzene-like hexagons with a Nitrogen between them. Molecular Dynamics Calculations were used to establish the type of disorder. The template can clearly be seen located in one position, indicating static disorder. From these finding and comparing them to other systems, we were able to conclude that the size of the template in combination with the pH value during synthesis are the major factors in the formation of one-dimensional microporous materials.

With these findings I was able to synthesize a novel type of layered aluminophosphate material, which might show interesting properties towards hydrogen storage.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Hydrocarbon Adsorption in Microporous Aluminophosphates

Description of the research activities:

Some carcinogenic compounds are found in Car Exhausts. Especially during the start up phase of the car (ca. 2 minutes), high amounts of aromatic hydrocarbons will be emitted as the catalytic converter has not yet reached its minimum working temperature. It would hence be of great use to develop a storage material which binds these compounds for a time until the catalytic converter has reached its working temperature. I was testing several different types of microporous Aluminophosphates as a storage devise for hydrocarbons in exhaust

fumes.

It is generally known, that in the presence of water hydrophobic materials tend to work better. However, in dry conditions hydrophilic materials outperform the equivalent hydrophobic ones considerably. Hence to maximize the ability of materials as good trapping agents, materials' attributes have to be altered to make them more hydrophobic or the environment needs to be changed, i.e. extract the water from the stream. Both these approaches have been looked at under this programme.

Firstly, capping agents for the hydroxyl groups in the material were introduced making it more hydrophobic.

Secondly, the environment was changed by mixing an H_2O filter into the material.

Capping agents eliminate the acidity of the material which seems to be in high correlation with its ability to store hydrocarbons. Indeed the capped material completely losses its ability as a hydrocarbon trap. This is a proof that the acidity of a material is indeed of high importance in storing hydrocarbons.

By introducing an H_2O filter however, the material's acidity is not affected and was hence expected to be a more promising approach. When mixing a filter in with our material we were able to reproduce results obtained in a dry environment even though water was present. This promising find will be further investigated by X-Ray Diffraction and further hydrothermal work to gain a better insight into the work done under this programme.

8. Please add your comments (if any): I would like to thank the JSPS for giving me this opportunity to enhance my research skills and allow me to explore a new culture at the same time. I furthermore would like to acknowledge all the help I have received by my supervisors Professor Sankar and Professor Catlow (Royal Institution of GB) and my host Professor Okubo and Dr Elangovan (University of Tokyo).

9. Advisor's remarks (if any): I believe that Mr. Dorner worked hard in the laboratory and found an interesting phenomenon through the experiments. His stay was also helpful for our students to learn a different culture. I express my heartfelt thanks to JSPS.

RESEARCH REPORT

1. Name: Hannah Kim （ID No.: SP05106 ）

2. Current affiliation: Imperial College London

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo University of Agriculture and Technology

5. Host researcher: Prof. H. Ohno

6. Description of your current research

Recently, the applications of ionic liquids (ILs) in synthesis and catalysis have generated interest in both academia and industries. Consequently it has led a dramatic expansion of this field, with 777 papers appearing in the year 2004 with ionic liquid in the title compared to just 80 in 2000.

Use of ILs as reaction media for catalytic asymmetric reactions have lead to three different strategies; i) IL as replacement for organic solvents; ii) IL used to stabilize catalyst and/or allowing recovery of catalyst; iii) IL as chiral promoter.

My current research concentrates on preparation of chiral ionic liquids (CILs) that may be utilized as a chiral promoter for a catalytic asymmetric Diels-Alder reaction. Two types of CILs have been prepared and characterized by various analytical methods including Kamlet-Taft measurements; i) chiral amino acid based ionic liquids ; ii) chiral alpha-hydroxy acid based ionic liquids. Preliminary investigations have shown that use of proline based CIL as a chiral promoter afforded a moderate enantiomeric excess.

Further investigations are under progress to establish a chiral promoter that will afford a sufficient enantiomeric excess to eliminate the subsequent separation steps thus reducing costs and preventing waste.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Preparation and characterization of chiral ionic liquids

Description of the research activities:

Ionic liquids may be described as salts that melt at or below 100°C to give liquids that consist only of ions. The development of chiral ionic liquids is still at preliminary stages of research with the majority of the studies being published after 2000.

Preparation and characterization of chiral amino acid tetraalkylphosphonium based ionic liquids was undertaken. The original procedure has been developed by Ohno *et al*. Some modifications of methodology were necessary to afford enantiomerically pure products. In addition to this, preparation of amino acid ionic liquids with the chirality settled on the cation and malic acid derivative based ionic liquids were attempted.

The products were analyzed with differential scanning calorimetry and thermogravimetric analyzer.

RESEARCH REPORT

1. Name: Rachel Macmaster （ID No.: SP05107 ）

2. Current affiliation: University of Sheffield

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Graduate School of Science and Engineering, Waseda University

5. Host researcher: Professor Kurumizaka

6. Description of your current research:

Resolution of the four-way branched DNA structure known as a Holliday junction by junction specific endonucleases is a critical process in genetic recombination and repair. The formation of Holliday junctions is usually catalyzed by RecA-like proteins and associated factors and often follows damage to DNA by double strand breaks or single strand gaps (Lloyd and Low, 1996; McGlynn and Lloyd, 2001) My current research involves the Junction resolving enzyme RusA from *E. coli.* The structure of the wild-type protein has been solved and reveals a new Holliday junction DNA binding fold (Rafferty et al. 2003). I have been working on a number of inactive mutants which bind to DNA but do not cleave it. I have solved the crystal structure of two of these mutants. Both of these mutants have been used in co-crystallisation experiments with various DNA constructs and a structure bound to DNA has been determined.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Investigation of the sequence specificity of *E. coli* RusA Resolvase in Holliday Junction Cleavage.

Description of the research activities:

RusA has a high affinity for cleaving 5’ to a CC dinucleotide located symmetrically within the homologous core of a Holliday junction. (Chan et al. 1997) From the current research it has come to light that one residue which is well conserved may interact with the DNA and be involved in the sequence specificity of cleavage. The research I propose is to produce a number of mutations of this residue and run a

series of tests to determine its role in the function of this enzyme. Professor Kurumizakas lab is an ideal place to carry out these experiments as they specialise in biochemical characterisation of the recombination proteins. My work in the lab has involved producing a number of mutants of this enzyme using the Quikchange protocol (Stratogene) in order to overexpress these mutants and test their activity and cleavage specificity using phospho-labelling and band-shift assays.

8. Please add your comments (if any):

I would like to thank Professor Kurumizaka for allowing me to work in his laboratory for the summer and for his advice and assistance. I would also like to thank all of the lab members for help with experimental procedures.

RESEARCH REPORT

1. Name: Jemma Morgan （ID No.: SP05110 ）

2. Current affiliation: University of Edinburgh, Scotland, EH9 5JJ UK

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Keio University, 3-14-1, Hiyoshi, Yokohama

5. Host researcher: Professor Hiromichi Ohta

6. Description of your current research

My current research involved the investigation of amino acid racemases for the possible use as amine racemases. I am currently using techniques such as directed evolution to broaden and probe the different possible substrate specificities of three amino acid racemases from different bacteria.

The second part to the research is the development of a high-throughput screen to detect racemase activity using a peroxidase capture method that results in colour formation.

One final aim in the project is to develop and use the screen to probe genomic libraries for novel enzyme activity as one screen can be used to detect a number of different enzymes.

7. Research implementation and results under the program

(As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

The deracemisation of secondary alcohols using oxidation/reduction factories

Description of the research activities:

I have isolated genes of interest from a range of sources, glucose dehydrogenase (GDH) from *Bacillus megaterium*, *S*-Mandelate dehydrogenase (MOX) from

Pseudomomas putida, and *R*-mandelate dehydrogenase (RMDH) from *Enterococcus faecalis* using PCR and genomic DNA. All amplifications were successful.

The first stage was to clone the MOX gene into pUC19 and detect successful cloning using blue/white screening. Digestion of the plasmid DNA using selective enzymes demonstrated which white colonies contained the MOX gene in the correct orientation for expression. These plasmids were designated pJAP1.

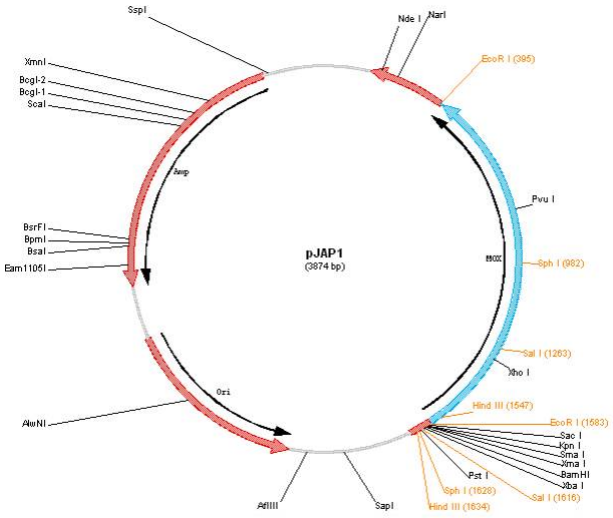

Figure 1: Plasmid map of pJAP1, origin = pUC19(MOX)

A whole cell assay showed the selective conversion of *S*-mandelic acid, from the racemate, to the prochiral keto-acid. This was achieved and shown by chiral HPLC.

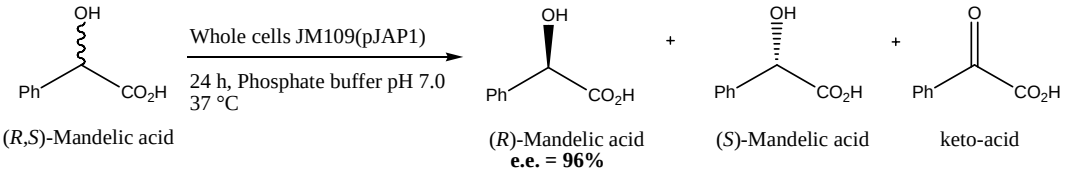

Figure 2: The whole cell conversion

The second stage involved the cloning of the other two genes into compatible plasmids for co-expression, pACYC Duet-1 and pET Duet-1, and demonstrating the conversion of the keto-acid to *R*-mandelic acid. A number of attempts were made to create the new plasmids but the genes of interest were never shown to insert into the vectors successfully.

To investigate the problem with cloning the second and third genes, the GDH gene was inserted into pUC19 and detected using the blue/white screening. The creation of this

plasmid was achieved in the first attempt, which indicates that the difficulty in cloning the genes into the co-expression vectors seems to be a problem with the host vectors themselves. A range of conditions has been tested and in conclusion it will be much faster to clone the genes into smaller vectors that can co-exist in the same cell comfortably.

RESEARCH REPORT

1. Name: John Townsley （ID No.: SP05111 ）

2. Current affiliation: Sheffield University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: AIST, Tsukuba

5. Host researcher: Prof. Kazunari Taira

6. Description of your current research

Synthesis and Study of Novel Stabilised 2'-Thionucleosides

2'-Thionucleosides were first synthesised several decades ago, although dimers and oligonucleotides containing these analogues have only recently been prepared. Studies performed on 2'-thio-containing dimers showed that the adjacent phosphorus is remarkably reluctant to attack leading to complete inhibition of transesterification and isomerisation of the phosphate diester linkage under both mildly acidic and basic conditions. However, despite resistance to the characteristic reactions of ribonucleic acids, 2'-thionucleosides and their corresponding dimers are highly unstable under basic conditions (pH >9). In order to exploit the desirable properties of 2'-thionucleosides we propose to prepare analogues of these molecules that possess stabilised glycosidic bonds.

7. Research implementation and results under the program

Title of your research plan:

To learn basic biomolecular techniques whiles also helping with a project involving production of novel HER2L binding proteins for use in drug delivery.

Description of the research activities:

The HER2L binding site tends to be over expressed on the surface of cancer cells. The aim of this project is to produce an antibody mimic that has two novel ligands that contain the HER2L binding protein. These two proteins are then

cross-coupled together through a novel linker designed and made by Prof. Taira's laboratory here in Japan. A range of nucleic acid/protein sequences can then be attached to the cross-linker for drug delivery.

The research I have been involved with is the production of the novel protein ligand. This is achieved by first ascertaining the amino acid sequence of the HER2L binding protein. From this sequence we can write down the most probable DNA sequence that will, when translated, produce the same amino acids sequence. This DNA sequence is then made via PCR and then ligated into a pre-spliced plasmid. The plasmid is then introduced into E.Coli and amplified. Expression of the HER2L sequence is then initialised and the HER2L protein is collected and purified and its sequence checked. If the sequence is correct the plasmid containing the HER2L sequence will again be spliced open and another DNA sequence can be inserted that will code for other desired functions needed in the new ligand.

8. Please add your comments (if any):

I wish to thank Prof. Taira and his staff for welcoming me and helping me grasp several new biochemical techniques that I other wise would have never had the opportunity to learn. They made my time here very enjoyable (even when climbing Mt Fuji) and also helped me when I didn't understand anything (or when I fell off my bicycle). I also wish to thank the JSPS summer program, as my time here in Japan has been an enjoyable and worthwhile experience. Without this program I feel I would never had experienced what it is like to live in such an amazing country as Japan.

RESEARCH REPORT

1. Name: Geraldine Newell （ID No.: SP05112 ）

2. Current affiliation: Loughborough University

3. Research fields and specialties:

Humanities Social Sciences XMathematical and Physical Sciences
Chemistry XEngineering Sciences XBiological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Industrial Health

5. Host researcher: Dr. Setsuo Maeda

6. Description of your current research

My previous research has been focused on characterising features of whole-body vibration exposure among off-road machinery operators throughout a range of industry sectors.

The physical comfort of operators is a basic ergonomic prerequisite for the safe operation of machinery. Vibration environments such as those experienced by operators driving off-road machinery can impose a number of physical problems. This exposure has often been reported to cause back pain and over long periods of exposure pathological changes could result in non-specific or diagnosable injury to the back. This hazard has been recognised by the European Union, subsequently a new legislation limiting worker's exposure to whole-body vibration has been enforced during 2005 'European Physical Agents (Vibration) Directive'.

Research was carried out under real operating conditions to investigate the levels of occupational exposure to whole-body vibration and to determine the causes of variability between measurements. During the months of February to November 2004 86 whole-body vibration measurements were taken on a variety of off-road machines at 14 different locations throughout the UK. This included two proving grounds, two granite quarries, one open cast coal mine, builders merchants, scrap metal yard, three construction sites and two landfill sites. Data was collected in three axes of vibration, vertical, horizontal and lateral. This database produced over ½ a billion data points for analysis.

The aim of the previous research was to:

- Investigate all the accepted methods used to assess vibration emission of off-road machinery
- Determine what factors contribute to variation of this emission value
- Investigate the contributing factors that can influence the vibration exposure that is omitted to the operator of off-road machinery.

Research has identified a greater risk of low back pain for drivers who frequently adopt driving postures in which the trunk is considerably twisted or bent forward. Vibration exposure has also been associated with back pain, yet previous research has failed to address these two risk factors in combination. Therefore it is important to understand the interactions between vibration exposure and non-neutral postures to improve understanding of the potential health risks imposed on professional drivers.

7. Research implementation and results under the program

Title of your research plan:

Effects of vertical vibration and twisted postures on human responses to whole-body vibration exposure

Description of the research activities:

My research has been conducted at the National Institute of Industrial Health, an independent institution under the Ministry of Health, Labour and Welfare. Comprehensive research on occupational health is carried out at the Institute with the aim of preventing occupational and work-related disease and injury in workers and to promote their health and comfort during their working life. My research was carried out in the Department of Human Engineering. This department has a highly specialised vehicle motion simulator (multi-axis shaker system), it has exceptional capabilities to recreate an accurate simulation of the real life vibratory environment experienced in any type of machinery.

The research study investigated the interactive effects of vibration exposure and non-neutral postures on the human body. Subjects were recruited from Tokyo Metropolitan University, 14 males and 1 female subject took part in the study. Subjects were exposed to two experimental conditions; vertical vibration exposure while sat in a neutral forward facing posture and vertical vibration exposure while sat in a twisted rearward facing posture. Two control conditions included sitting in

a neutral forward facing posture and sitting in a twisted rearward facing posture without vibration exposure. The four conditions were repeated three times, this created 12 conditions presented in a randomised order. Subjects were exposed to a random vibration signal 1-20 Hz, with an overall vibration magnitude around 1.0 m/s^2 r.m.s., this magnitude is typical for the types of off-road machines that impose the greatest health risk for the operators. Three different techniques were used to record the biomechanical and physiological responses of the subjects during exposure to the different conditions. The apparent mass of the subjects was calculated to determine what frequency the human body would resonate under the different conditions, seat-to-head transmissibility and roll, pitch and yaw were calculated to determine how much vibration was transmitted through the spine to the head and what affect this had on the movement/rotation of the head. The third measure utilised electromyography to determine how much muscle activation occurred in the erector spinae muscle around the lower lumbar vertebrae between L1 to L3. This is the area of most interest as back pain is often reported in the lower back where higher stresses can be found.

Findings from the study have shown interesting results using the three different techniques. Apparent mass data indicated a small increase in the peak resonance value during the normal seated posture compared with the twisted posture condition. The seat-to-head data, however, has shown an increased transmission of vibration through the spine to the right side of the head while seated in the twisted posture, this finding is consistent for the majority of subjects. Conversely the transmission to the back of the head is increased during the normal posture condition, this is not surprising as the back of the head is positioned directly in line with the vibration source during the normal seated condition. The electrical activity of the right erector spinae muscle elicits the greatest activation during the twisted posture condition with vibration exposure.

The findings from this study will directly feed into my PhD thesis and it is anticipated that up to three journal articles will be written from this research.

8. Please add your comments (if any):

The summer programme has been an excellent introduction into Japanese working practices and culture. I have learnt many new techniques in the laboratory that I have not used previously and successfully programmed new software to carry out these techniques. In combination with the research I have also interacted with many representatives of Japanese companies including the equipment suppliers and representatives at the Japan Human Response to

Vibration Conference, where I presented a paper on my current research. Throughout the summer I have also visited three different companies and the Tokyo Women's University. This experience was most beneficial for gaining an insight into the application of research in Japanese Industries.

9. Advisor's remarks (if any):

Miss Geraldine Newell (ID: SP05112) did very well during two months at Department of Human Engineering of National Institute of Industrial Health. I think she has an excellent ability to do the research works. Therefore, she will be able to become a candidate of JSPS Postdoctoral Fellowship Program for Foreign Researchers next year.