Okayama University

Okayama University Young Researchers' Conference

Faculty of Engineering

Special Advanced Course for Core Science
1/20/2011

Contents

Note of Welcome


It is my sincere wish to welcome you to the 2011 Okayama University Young Researchers' Conference. Okayama University puts great effort and emphasis on developing the research and English skills of its students. This conference is a setting designed to give our young researchers the experience of synthesizing, preparing and delivering a presentation or explaining their areas of interest through a poster in English in a conference setting. I believe this will be an invaluable experience for them in their future careers. The presenters today are from a range of disciplines: robotics; superconductivity; to genetic engineering; to porcine insemination among others. Enjoy! Perhaps no other conference in Japan reflects such research diversity. If I may add a request to the attendees; please remember this is an **English** conference so **all** communication should take place in English. In conclusion I would like to thank you again for your interest and support and I would also like to thank the presenters for their efforts.

Yours sincerely,

Harada Isao, PhD

C.J.Creighton

Chairpersons

Presentations

The performance evaluation of Li-ion capacitor using polyacrylonitrile electrodes

AKIYAMA Naoki

ABSTRACT

Recently, studies of performance in Li-ion capacitors using electrodes of various carbon materials have been reported. These studies have been done in order to develop alternatives to Li-ion batteries. Li-ion capacitors are safer than Li-ion batteries. The experiment reports on the performance evaluation of Li-ion capacitor using electrodes prepared from polyacrylonitrile fiber (PAN). The question is whether the Li-ion capacitor using PAN electrodes including 1% cellulose fiber (PANc electrodes) is better than the one using PAN electrodes in charge-discharge characteristics and whether the structure of carbon materials affects the performance. We prepared electrodes of carbon prepared from PAN and PANc. We carried out following two measurements after we incorporated the electrodes into an electrochemical cell, (1) the constant current charge-discharge measurement in the range of operating voltage, 25~500mV, (2) the measurement of specific surface area of the PAN carbon fiber and the PANc carbon fiber. The charge-discharge capacity of Li-ion capacitor using PANc electrodes was higher than that of Li-ion capacitor using PAN electrodes. The discharge capacity of PANc electrodes was ca.55 mAh/g and that of PAN electrodes was ca.45 mAh/g. There are differences of specific surface area between carbon materials prepared by PAN and prepared by PANc. The specific surface area of PANc was larger than that of PAN. PANc electrodes were better than PAN electrodes in charge-discharge characteristics. We discuss these results in light of future development and the significance of the alternatives of Li-ion batteries.

Keywords: carbon material, electrochemical cell, lithium ion capacitor, polyacrylonitrile.

Numerical simulation of the flow around a rotating disk in a wafer cleaning chamber

KUMEDA Takateru

ABSTRACT

The cleaning process of a silicon wafer is important in the manufacturing of semiconductors and determines the quality of the finished products. In single wafer cleaning, after a wafer washed with cleaning solution and rinse liquid was dried by high

speed rotation, there is a potential problem if dust and mist attach to the wafer. In order to solve this problem, it is necessary to understand air flow in the wafer cleaning chamber. The experiment reported here is a numerical simulation of the flow around a rotating disk in a closed cavity as a model of the wafer cleaning chamber. The researchers simulated the air flow with OpenFOAM, a Computational Fluid Dynamics (CFD) software package in order to simulate the flow around a rotating disk, and Blender, a 3D content creation suite, to make 3D mesh models of a closed cavity and a disk. We measured the influence of changes in the flow around a rotating disk upon changes of rotation rates. The results of this simulation can be used to design more useful wafer cleaning chambers.

Keywords: wafer cleaning chamber, air flow, rotating disk, numerical simulation, OpenFOAM, Blender.

Fabrication of AlN ceramics with highly thermal conductivity by milliwave-HIP combination sintering method

YAMASHITA Kyohei

ABSTRACT

Aluminum nitride (AlN) is considered to be a promising material for microelectronic packaging because of its high thermal conductivity, but AlN is difficult to sinter because of a covalent bond material. For this reason, sintering additive and/or high sintering temperature are needed to fabricate AlN ceramics.We investigated the effects of sintering conditions including sintering additive amount and sintering temperature on the thermal conductivity of aluminum nitride ceramics with Y_2O_3 additives. AlN powder with Y_2O_3 powder were mixed with acetone in a ball mill and formed into pellets, and the AlN specimens were fired by milliwave sintering. The thermal conductivity values of AlN ceramics sintered were improved after decreasing the sintering additive amount and increasing the sintering temperature. In current research, an AlN ceramic with thermal conductivity as high as 179.9 $W \cdot m^{-1} \cdot K^{-1}$ was obtained by sintering 1wt% Y_2O_3 doped-AlN specimen at 1800℃for 0.5 h with milliwave under a reducing 3vol.% H_2 added-N_2 atmosphere. In view of these results, we discuss the possibility to fabricate AlN ceramics with higher thermal conductivity under mild conditions by changing the amount of Y_2O_3 additive and the temperature of milliwave sintering. In addition to milliwave sintering, we can improve density and thermal conductivity of the AlN ceramics by HIP (Hot Isostatic Press) sintering.

Keywords: aluminum nitride; thermal conductivity; sintering additive; milliwave sintering; HIP.

Research on polyspermy obstruction in porcine oocyte in vitro fertilization

NAKAKOUJI Munehiro

ABSTRACT

Despite advances in porcine artificial insemination techniques, the incidence of the polyspermy, when two or more sperms inseminate one oocyte, is still higher than that of other livestock. The rate of normal diplont embryos decreases when the polyspermy is generated therefore decreasing the productive efficiency of production life and the embryo. Experiments to obstruct polyspermy have been performed. When oocyte cultures use follicle fluid, the polyspermy rate was decreased. It is suggested that the hardening before fertilization of the Zona Pellucida(ZP) that covers the oocyte, decreases polyspermy rate. It was also shown that the size of the perivitelline space is related to the frequency of polyspermy with reduced perivitelline space increasing polyspermy. The present study demonstrates the effects of adding sorbitol to the in vitro fertilization medium, adjusting the osmotic pressure, and adjusting the size of the perivitelline space. First we observed the change over time of the size of the perivitelline space in the 100mM sorbitol medium. There were significant changes between 0min and 5min (from 1.87±0.10μm to 4.48±0.25μm). Second, we examined the change of the perivitelline space size of the oocyte soaked in varying concentrations of sorbitol (0mM,25mM,50mM,75mM,100mM). It was found that the perivitelline space size significantly became bigger depending on the concentration of sorbitol. In the medium with non-sorbitol (0mM), the perivitelline space size significantly did not significantly change (from 2.10±0.09μm to 2.01±0.11μm), but with the highest concentration of sorbitol (100mM), the perivitelline space size changed from 1.87±0.10μm to 4.48±0.25μm. In future research we will demonstrate the influence on polyspermy by exposing oocyte to different densities of sorbitol medium.

Keywords : in vitro fertilization, polyspermy, perivitelline space.

Optimal Intersample Digital Servo Control Design for Handling Machines

AKIYOSHI Tatsuro

ABSTRACT

Continuous-time plants with continuous-time controllers, which are often used today, do not yield stability when the sampling rate more than 10[ms]. Until now, however, expensive controllers have been used to make continuous-time controllers for high functioning electronic control. Low cost controllers do not have a fast enough sampling rate. This paper shows whether a cheaper controller with sampled-data control theory

can control plants effectively. We designed and manufactured a controller of an embedded system for an industrial robot by using sampled-data control theory with built-in intersample behavior. We applied it to a simulation and a real machine. In this paper, the controlled plant is a wafer handling machine in semiconductor plant as part of an electromechanical system. Target behavior was up and down, the angle was from -5 to 5 degrees, and the rate was 10 cycles at 10 seconds per cycle. Using a low-cost controller and sampled-data control theory this experiment achieved a zero percent steady error and from 0.5 to 1 second reached the target value for extended sampling periods of 100ms. Digital implementation of the embedded system with performance-limitation had similar results to high spec controllers. As a result, the use of low cost controllers with sampled-data control theory makes it possible to reduce costs. Our research has lead to the viability of lower cost and higher performance systems for factory production.

Keywords: sampled-data control theory; intersample; low spec and high performance.

Collective motions of small particles in two-dimensional turbulence

ADACHI Masataka

ABSTRACT

Understanding water flow mixed with particles in pipes is very important in industry. Numerical simulation of small particles like microbubbles, however, is complex requiring tracking several thousand particles and constantly calculating particle transformations. In addition, electromagnetic forces, fluid body forces and particle collisions act on the particle behaviour. Researchers have developed many equations, but there is not a perfect theory. The purpose of this study is to use Force-coupling-method (FCM) to describe flow with particles. We used FCM for calculating turbulent flow in three dimensions. FCM calculates the velocity, a force monopole, and the trajectory, a force dipole, for each particle. A force monopole and a force dipole generate a body force distribution on the fluid. The final goal is perfect theory. As a first step, the two dimensional homogeneous isotopic turbulent flow in a cycle boundary was examined. Making and testing a computer program was practiced. The force monopole was calculated. For further research, the computer program should be parallelized for use on super computer to calculate the force dipole.

Keywords: numerical simulation, fluid dynamics, microbubbles, turbulence, collective motions.

Synthesis of the 3*H*-azepine and its silicon derivatives

HISAKO Taira

ABSTRACT

The 3*H*-azepine is a seven-membered cyclic compound, having nitrogen at the 1-position and two hydrogens at the 3-position. The parent 3*H*-azepine was first reported by E. Vogel et al. based on low-temperature NMR spectroscopy, and was found to be very unstable under ambient conditions. The synthesis of stabilized 3*H*-azepine having an alkoxy or amino group at the 2-position has been well studied, for example, 5-*tert*-butyl-2-methoxy-3*H*-azepine (3). The researchers were interested in 5-trimethylsilyl-2-methoxy-3*H*-azepine (6), which is a silicon derivative of (3). The trimethylsilyl group is known as an unstable substituted group. The question was whether the azepine (6) having trimethylsilyl group at the 5-position would change to a new substance. In order to research the reactivity of (6), the researchers synthesized two azepines. Nitration of *tert*-butylbenzene (1) gave *p*-*tert*-butylnitrobenzene (2). Reaction of (2) with tributylphosphine and methanol gave 5-*tert*-butyl-2-methoxy-3*H*-azepine (3). Phenylnitrene was generated by treatment of (2) with tributylphosphine. It was very unstable. The ring expansion occurred through the transition of the nitrene. Next, the researchers studied the derivative of silicon, 5-trimethylsilyl-2-methoxy-3*H*-azepine (6). (2) has a *tert*-butyl group, whereas trimethyl-*p*-nitrophenylsilane (5) has a trimethylsilyl group. Both *tert*-butyl group and trimethylsilyl group have electron releasing properties, but these are considered different. It was assumed that formation of (6) would fail. However, reaction of 5 with tributylphosphine and methanol also gave (6). (5) was obtained by nitration of 1,4-bistrimethylsilylbenzene (4). In this paper, synthesis of two azepines is described.

Keywords: synthesis of azepine, nitration, tributylphosphine, Phenylnitrene, *tert*-butyl group, trimethylsilyl group, derivative of silicon, electron releasing properties.

Function analysis of the PduO protein as a member of diol dehydratase system

TANOKUCHI Aya

ABSTRACT

The PduO protein is the enzyme called adenosyltransferase(AT). Three types of cells from all living thing synthesize AT : CobA which exists in biosynthetic pathways, PduO which exists in the pdu operon, and EutT which exists in the eut operon. It is thought that the inactive form cobalamin is converted into AdoCbl by using the AT and AdoCbl is cycled. Studies do not report which kinds of AT are present in the cycling system. Because the gene order of diol dehydratase(DD) exists in the pdu operon, it is possible the AT of the cycling system is PduO. The experiment reported here asks if PduO is the AT of the cycling system. We identified that in vitro, the inactive formed enzyme's

complex is activated when PduO is made to react with inactive form DD, DDR, reductase, and ATP. Moreover, we add CobA or EutT instead of PduO and investigated the respective level of activation to see if PduO is a member of the cycling system. It appeared that the PduO protein generated AdoCbl from the inactive form cobalamin in the cycling system. However we have no data about CobA and EutT yet. PduO function in a diol dehydratase system is useful for the reaction converting glycerol produced as byproduct when diesel fuel is made from vegetable oil.

Keywords: adenosyltransferase(PduO,CobA,EutT), AdoCbl, diol dehydratase, cycling system, activation, converting glycerol.

Analysis of the mechanism that B cells proliferate and produce high-affinity antibodies under low oxygen concentration in germinal center

IWASAKI Eriko

ABSTRACT

Immune response is a mechanism which detects many harmful substances called antigens such as viruses, bacteria or pathogens and eliminates them from our bodies. In immune response, proteins called antibodies are one of the molecules which are produced by B cells. For protection against infection, the germinal center (GC) is an important site for the generation and selection of B cells bearing high-affinity antibodies through somatic hyper mutation under 5% O_2 concentration (atmospheric O_2 concentration is 20%). High-affinity antibodies can bind to antigens easily and tightly, so they become more effective to detect and eliminate antigens. The follicular dendritic cells (FDCs) present in GC are associated and play a critical role, although the mechanisms and factors inducing high-affinity antibodies are unknown. Previously, to explore a key role of FDC, we established a mouse cell line named FL-Y that retains a number of functions and phenotypic markers of FDC. During studying FL-Y functions in GC reaction, we found that co-culture of FL-Y with splenic non-B, non-T cells resulted in expansion of a novel myeloid cell, which was named FDC-dependent myeloid lineage cells (FDM). We focused on the mechanisms inducing high-affinity antibodies in experiments with mice, FL-Y and FDM. FL-Y and FDM induced B cells expressed high-affinity antibodies. Especially, FDM strongly augments the proliferation of anti-CD40-stimulated B cells in vitro, concomitant with increased expression of GL-7 and Fas on these B cells (GC B cells) which differentiate into antibody-produced B cells. We found that B cells, FDM, and some kinds of cytokines (stimulation factors) which co-culture under 5% O_2 concentration increase B cell division, viability, and high-affinity antibody-produced B cells about twice compared with 20% O_2 concentration. We also examined at genetic level whether co-cultured B cells express

specific genes to high-affinity antibody-produced B cells such as *AID*, *Bcl6*. The research team is looking for a mechanism that produces high affinity antibodies using mice and the above-mentioned cells. If we are successful, more effective antibody drugs could be made.

Keywords: immune response, high-affinity antibody, B cell, germinal center (GC), 5% O_2 concentration, somatic hyper mutation, follicular dendritic cell (FDC), FL-Y, FDC-dependent myeloid lineage cell (FDM)

Use of an acidophilic bacteria aimed at recombinant expression under acidic conditions and Expression of a target protein

SATO Tsubasa

ABSTRACT

Acidithiobacillus ferrooxidans is an acidophilic, obligatory chemolithoautotrophic bacterium able to derive energy from the oxidation of reduced inorganic sulfur compounds. Several pathways have been suggested for the oxidation of reduced inorganic sulfur compounds in this bacterium. One of the most important intermediates in dissimilatory sulfur oxidation of this bacterium is tetrathionate which can be utilized as a sole energy source. Tetrathionate hydrolase (4THase) is a key enzyme in tetrathionate oxidation. Although 4THases have been purified and characterized from several acidophilic chemolithoautotrophic bacteria belonging to the genus *Acidithiobacillus*, the information on this enzyme is limited. In order to advance the characterization of the enzymatic and biological properties of the 4THase, the recombinant protein of 4THase of *A. ferrooxidans* was synthesized in large numbers in E.coli. However, the recombinant protein was an inactive form. In the following study, the enzyme showed the maximum activity at pH 3.0 and high stability under acidic conditions. However E.coli can’t grow in acidic conditions therefore the research team isolated an acidophilic bacterium (from water and soil sampled in Yanahara Mine, Okayama city) instead of E.coli. The research team is going to try the recombinant expression described above by using this isolated bacterium in acidic conditions. Development of this method is going to support producing 4THase and other enzymes (being active form under acidic conditions only) in large numbers.

Keywords: tetrathionate hydrolase; sulfur metabolism; acidophilic bacteria; recombinant expression.

Posters

The effect of impurity on $Li_2Pd_3B_{1-x}Al_x$

ARIMA Kazuhiro

ABSTRACT

Superconductivity is the state where electric resistance is zero when matter is cooled to a very low temperature. The temperature to become superconductive is called “critical temperature” (Tc). Each superconductor has an inherent critical temperature. It is reported that the highest critical temperature has been 138K (-135 degrees). Li_2Pd_3B is superconductive at 8K (-265 degrees). In addition, Li_2Pd_3B is a superconductor with broken inversion symmetry. The experiments reported here examine the effects of impurity on superconductivity by replacing boron with aluminum. $Li_2Pd_3B_{1-x}Al_x$ is obtained by melting the materials at a high electrical current. It is one of the main themes of this research to examine what kind of property this matter has by changing the mole ratio of aluminum from 0% to 100% at 10% intervals (subscript x is the ratio of aluminum). The work of replacing boron with aluminum is in progress. Till now, 60% boron has been replaced with aluminum. The goal is to replace boron with 100% aluminum. The most important result is that the more boron is replaced with aluminum, the lower critical temperature of $Li_2Pd_3B_{1-x}Al_x$. It is thought that at a high mole ratio of aluminum $Li_2Pd_3B_{1-x}Al_x$ does not become superconductive. It is important to find this ratio. After finding the ratio of aluminum where $Li_2Pd_3B_{1-x}Al_x$ does not become superconductive, it is planned to examine electron state and spin state for each ratio of aluminum by using NMR (Nuclear Magnetic Resonance).

Keywords: superconductivity, critical temperature, Li_2Pd_3B, impurity, NMR

Structure stabilization of Glycerol Kinase from *Cellulomonas* sp. bacteria

FUJII Shigeki

ABSTRACT

Many microorganisms, for example bacteria, fungi and yeast, are useful as systems which produce substances. The requirements to apply various microorganism resources for industry are quality, quantity, cost and environmental load-reducing. Enzymes from thermophilic microorganisms have high optimum temperature. Protein thermostabilization has been studied based on the common ancestor hyperthermophile theory. Glycerol Kinase(GK) catalyzes the transfer of phosphate group from ATP to glycerol and produces glycerol 3- phosphate. Thermophilic soil bacteria *Cellulomonas*

sp. produce GK which tolerates preservation. Using genetic engineering techniques, we introduced DNA plasmids from *Cellulomonas* sp. into *E. coli* through transformation and changed genetic sequences through mutation. We used some biochemical assays to examine the enzymes produced by *E. coli* to measure their activity or the improvement in their thermostatability. Several enzymes were made and some of them had activity and improved thermostatability. Notable enzymes were purified with some column chromatography. We analyzed their three-dimensional structures and identified differences in their conformation with analysis software. These new enzymes produced by *E. coli* may lead to development of clinical trial drugs or to industrial uses because they showed improved thermostatability and preservation stability. The result of this study suggests that there is a relation between structure and function of the protein.
Keywords: thermophilic microorganisms, common ancestor hyperthermophile theory, Glycerol Kinase(GK), *Cellulomonas* sp., *E. coli*, transformation, mutation, thermostatability, three-dimensional structures

Characterization of low crystalline iron oxides produced by iron oxidizing bacteria, *Leptothrix ochracea*

SAKUMA Ryo

ABSTRACT

It is well known that microorganisms produce inorganic compounds such as calcium phosphate, silica, manganese oxide, and iron oxide. Especially, iron-oxidizing bacteria create unique shaped iron oxides, such as microtubules, twisted stalks, and capsules. These iron oxides have not been used for industrial purposes. To use such iron oxides as industrially, controlling the material particle size necessary. In this research, we studied the characterization of bacterial origin iron oxide and its nano-sizing. The iron oxide produced by *L. ochracea* was characterized by microscopy and crushed by using a planetary ball-mill with 30 □m and/or 0.7 mm zirconia beads. The sample was composed of globular particles with the diameter of several tens of nanometers and these particles were intricately aggregated to form microtubules 1 □m in diameter. The crushed samples were separated by size and their size-distributions were measured by granulometry. We obtained primary agglomerated particles ranging from 200nm to 500nm in diameter and secondary agglomerated particles ranging from 0.5 □m to 3 □m. We found that our sample was composed of uniquely shaped microtubules and clarified well dispersed submicron-sized iron oxide particles.

Keywords: iron oxide, *Leptothrix ochracea*, microtubules, nano-sizing, planetary ball-mill, granulometry.

The effect of electric field for water-in-oil emulsion in continuous flow

Ryota Kakimoto

ABSTRACT

Emulsions have been used in chemical engineering processes. Emulsions have advantages and disadvantages for processing. An advantage is the rapid chemical reaction and a disadvantage is slow separation. Separation of water-in-oil emulsion by electric fields has been studied in containers; water-in-oil emulsion can be separated by application of a continuous flow electric field. The experiments reported here show the effects of various parameters on separating water-in-oil emulsion. We used an emulsion containing rapeseed oil (80 percent volume), ion exchanged water (20 percent volume) and a little surfactant. The effects of (1) intensity of electric field and (2) electric field pulsation frequency on separating the emulsion were examined. Separation efficiency is defined as the separated water content divided by initial water content. The separation efficiency increased to 80% when the electric field strength increased to 3000V/cm, and a further increase in electric field strength from 3000V/cm to 20,000V/cm resulted in an additional 20% increase to about 100% efficiency. Pulsation frequency had a slight effect in high electric field strength, but separation efficiency improved with the increase of pulsation frequency in a low strength electric field. Applying the high electric field strength to water-in-oil emulsion can obtain high separation efficiency. This result has possible applications, for example, incineration of water and oil mixtures, and extraction processes.

Keywords: water-in-oil emulsion, electric field, pulsation frequency, separation

Photoemission Spectroscopy of the Metal-Insulator Transition in VO_2/TiO_2

NAGAO Hiroki

ABSTRACT

VO_2 has a characteristic of metal-insulator transition(MIT) at 340K. When the temperature is higher than 340K, it is metal and when the temperature is lower than 340K, it is an insulator. The crystal structures change between the metal phase and the insulator phase but the mechanism is not clear. Researchers suggest the Spin-Peierls mechanism where electron-electron interactions influence the MIT or the Mott mechanism where electron-lattice interactions influence the MIT. We made VO_2 thin films and examined them with photoemission spectroscopy (PES). PES is an experimental technique that observes the electron orbits. PES is a way to observe

directly the electron situation. If radiated rays hit objects, they emit electrons in the orbits. PES can observe the kinetic energy of electrons in one orbit. PES changes kinetic energy into a binding energy providing some information on electron states. The present research used angle-resolved Photoemission Spectroscopy (ARPES) to observe the electron states of VO_2. Using ARPES allows researchers to measure the band structure of VO_2 which may provide important information about MIT.

Keywords: VO_2 thin film, ARPES, MIT, Mott-Hubbard, Spin-Peierls

The functional analysis of MMAA and MCM enzymatic activation

NISHIKAWA Takuro

ABSTRACT

Methylmalonyl-CoA mutase (MCM) is a catalytic enzyme in the participation of vitamin B12 coenzyme. The reaction is reversible isomerization between methylmalonyl-CoA and succinyl-CoA. Catalytic enzymes in the participation of vitamin B12 coenzyme are classified into class 1, class 2, and class 3 by the catalytic reaction. Each class can be inactivated by the disappearance of the radical intermediate. The reactivation protein has not been reported for class 1 enzymes including MCM though the protein that activates the inactivated enzyme again for class 2 has been discovered. We speculate that MMAA(methylmalonic aciduria type A) is reactivation factor for MCM. In order to clarify whether MMAA acts as MCM reactivation factor in my research, the research team studied the functional analysis of MMAA and MCM. We used E.coli for getting MCM gene and proteins and MMAA´ proteins which are assumed to be reactivation or activation enzyme for MCM. We used these proteins for examining the interaction between MMAA and MCM by measuring enzymatic activation. It is known that the malfunction of MCM leads to methylmalonic aciduria to cause underdevelopment and intelligence disorders, and the mutation of the MMAA gene is reported as one of the causes.

Keywords: MCM, MMAA, vitamin B12, reactivation enzyme

Fabrication of cylindrical ceramics with a helical through hole using the superplastic foaming method

OKADA Masanori

ABSTRACT

“Superplasticity” is the phenomenon which certain solid matter is deformed by constant weak force in high temperature. “Superplasticity” is confirmed in some ceramics such as ZrO_2 (zirconia). The ceramics have high strength, so it is very difficult to convert

them. Through “superplasticity”, it can be very easy to produce the ceramic foams which have a uni-hole (pore) in it. The research team intends to produce cylindrical ceramics which have a helical through hole by “Superplastic Foaming Method”. To make a helical hole, we must set a bloating agent in the matrix powder at the time of shape forming. After sintering, we can produce the ceramic foams which have uni-holes. If we use a liner bloating agent sheet to paste around the smaller cylindrical matrix compact, and envelope it with matrix powder, firming by pressure and sintering it, cylindrical ceramics which have a helical through hole can be produced. For now, the research team has succeeded in producing cylindrical ceramics which have a hole going once around the ceramics. Future research will investigate making cylindrical ceramics which have the through hole going around twice. Ultimately, the research team aims at using the ceramic holes as high strength reaction tubes that can be used at high temperatures.

Keywords: ceramic foam, superplasticity, superplastic foaming, helical through hole.

Evaluation of corrosion resistance pure Ni and Ni origin alloy

MIYAMOTO Takuma

ABSTRACT

Nickel has excellent corrosion resistance therefore measuring natural corrosion takes a very long time. The research team thus evaluated Ni and Ni origin alloy corrosion-resistance using electrochemical measurement which is much faster. 3 samples, pure Ni, duplex Ni and Zn-Ni alloy, were tested using a Quartz crystal microbalance (QCM) and impedance measurement. QCM is a novel method applied in the field of chemical interfaces. Impedance measurement is the most convenient and accurate method used to evaluate the protection efficiency of the surface films of metals and alloys in various environments. We measured the impedance of the samples, and data obtained from this experiment was shown by a Nyqist diagram. We found that the impedance of the Zn-Ni alloy was lowest (16Ω) and that of pure Ni was highest (497Ω) with the higher values having better corrosion resistance. Zn-Ni alloy had the lowest corrosion resistance among the 3 samples. Next, we used the QCM method to find corrosion potential from observing the change of weight for plating. The corrosion potential of pure Ni, duplex Ni and Zn-Ni alloy were about 0.7V, 0.5V and -0.3V, respectively. In this case, the sample which has more positive corrosion potential has better corrosion resistance. Thus, Zn-Ni alloy had lowest and pure Ni had highest corrosion resistance. In duplex Ni the upper layer contains S element, which effects the corrosion potential of duplex Ni because it is less noble than pure Ni. This upper layer behaves as a sacrificial corrosion protection for the under layer. Thus, we conclude that the corrosion resistance of Zn-Ni

alloy was lowest and of duplex Ni was highest among the 3 samples.

Keywords: corrosion resistance; impedance; QCM; corrosion potential

Creation of Valuable Antibodies to CD20 by an In vitro Antibody Generation System Using a Hyper-mutation B Cell Line DT-40 System

SAI En

ABSTRACT

“DT-40 system” is a novel in vitro antibody generation system. This system uses a chicken B cell line DT-40, which displays Anti-bodies and mutates immunoglobulin genes during culture, and thereby generating a useful anti-body library for screening monoclonal anti-bodies (mAbs).CD20 is a protein that is highly expressed on B cells. Anti-CD20 monoclonal anti-bodies are being used as therapeutics for leukemia. The purpose of this study is using DT-40 system to create more valuable anti-CD20 anti-bodies, to develop technology to create valuable anti-bodies, and demonstrate the possibility of the system. We generated mAbs that can bind to a transmembrane protein, CD20, highly expressed on B cells. We generated an antigen model of CD20. We expressed CD20 protein from DT-40 cell to keep the antigen conformation. We also expressed mouse-CD4 protein from the cell as a cell marker. Using this antigen we obtained an anti-CD20 antigen-specific DT-40SW cell clone. The result will indicate whether we have established various clones producing mAbs that are specific and have a high affinity with antigen in a more efficient and rapid fashion with the DT-40 system. The use of the DT-40 system may enable the production of useful antigen drugs and diagnostic drugs.

Keywords: immunology, antibodies, DT-40, CD20, leukemia, CD4

The superconducting transition temperature of the platinum based arsenide SrPt2As2

TANI Yoshihiko

ABSTRACT

When specific metals and compounder are cooled down to very low temperatues, they become superconductive. A superconductor behaves free of electronic resistance under very low temperatures, but the principle has yet to be elucidated. A challenge for researchers is to find new types of superconductor, to clarify the electron state and to raise the temperatures at which materials become superconductive. The research team focused on a novel platinum-based arsenical superconductor SrPt2As2. SrPt2As2 has a particular crystal structure. The research team adopted nuclear magnetic resonance (NMR) imaging to research the behavior of SrPt2As2. NMR show details of the nucleus

and electron state, such as the motion of electron spin and the interaction between the nucleus and electrons. SrPt2As2 entered into a superconducting state at 5.2K and underwent both a charge density wave (CDW) transition at 470K and a superconducting transition at 5.2K. We discuss the result that the superconductivity at 5.2K coexists with CDW in SrPt2As2. CDW instability is one consequence of a Fermi surface nesting when interaction between phonon and electron remains important. Fermi surface nesting is a possibility for realizing a high transition temperature. The superconducting transition temperature (Tc) of SrPt2As2 is considerably higher compared with the other non-iron-based arsenides with the same crystal structure such as SrNi2As2 (Tc = 0.62K). The research team expects that discovering the behavior of SrPt2As2 will give a better understanding of superconductivity.

Keywords: physics, superconductivity, electron state, NMR, charge-density-wave, arsenide superconductor

Electric structure of the $Ca(Fe_{1-x}Rh_x)_2As_2$ by soft X-ray photoemission spectroscopy

TSUBOTA Koji

ABSTRACT

In a recent study of the parent iron arsenide compound $CaFe_2As_2$, it was possible to transfer collapsed tetragonal (cT) phase under very high pressure. In $CaFe_2As_2$, there are three crystal structures, antiferromagnetic tetragonal (T) phase (superconductor phase), paramagnetic orthorhombic (O) phase, and collapsed Tetragonal (cT) phase. The cT phase is different from T phase in the one directional axis of the unit cell length (the c-axis). The increase of pressure induces the phase transition. When the cT phase appears the length of the c-axis shortens. The electric structure of the transfer T-cT phase has not been understood, because it can only observed under high pressure but photoelectron spectroscopic method can only measure at ordinary pressure. We investigated variations in the electric transfer structure of $Ca(Fe_{1-x}Rh_x)_2As_2$ which can transfer T-cT phase under ordinary pressure, related to change in the quantity of the Rh doping. To indentify the electric structure, we used the Super Photon ring-8(SPring-8) to use soft X-ray spectroscopy. We measured the materials which had been doped x=0, 0.75, 0.2, and we observed the changes of the rigid band shift of the composition and the different valence band of the materials. In conclusion, the difference of the electric structure gives us a hint as to the cause of superconductivity and magnetic transition.

Keywords: collapsed tetragonal phase, superconductor, electric structure, photoelectron, spectroscopic method, Rh doping, band shift

Electrodeposition of Ni-W-C and Ni-W-SiC nanocomposite coatings

YAMASAKI Kaori

ABSTRACT

In recent years, Ni-W coatings have been used in many areas because of their hardness and wear resistance. Nanoparticles are added in Ni-W coatings to get various properties. For example, SiC nanoparticle is frequently studied for its properties such as hardness, oxidation resistance and chemical stability. The experiments reported here ask whether Ni-W coatings, Ni-W-C nanocomposite coatings and Ni-W-SiC nanocomposite coatings can be obtained by electrodeposition. Ni–W plating bath is composed of $NiSO_4 \cdot 6H_2O$, $Na_2WO_4 \cdot 2H_2O$ and citric acid. The operating conditions for plating were variously changed. Ni-W-C and Ni-W-SiC nanocomposite coatings were obtained by electrodeposition in Ni-W plating bath containing carbon and SiC nanoparticles. Deposits were characterized using energy dispersive X-ray analysis (EDX) and the surface morphologies of coatings were observed using a scanning electron microscope (SEM). Ni-W coatings which have high tungsten content percentage were achieved under control of operating conditions. When the bath was at pH6, temperature at 60℃ and current density at 10 A/dm^{-2}, the tungsten content percentage reached maximum. SEM studies showed that Ni-W-C nanocomposite coatings contained some carbon particulates. However, EDX couldn't identify C particles. The weight percentage of the co-deposited C nanoparticles was not shown. Ni-W-SiC nanocomposite coatings were not obtained, so the plating bath needs an addition of some surfactant. These nanocomposite coatings have the possibility to have excellent wear resistance at high temperatures.

Keywords: Ni-W coating; wear resistance; electrodeposition; Ni-W-C nanocomposite coating; Ni-W-SiC nanocomposite coating; nanoparticle

Determining reductase for coenzyme B12 recycling system.

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ABSTRACT

Dioldehydratase is an enzyme which converts glycerol to 3-hydroxypropionaldehyde. 3-hydroxypropionaldehyde becomes materials like water absorptive polymers or chemicals in anaerobic conditions. Dioldehydratase which needs coenzyme B12 works as an important enzyme, but dioldehydratase is inactivated if coenzyme B12 breaks during the enzyme reaction which happens frequently. The broken coenzyme B12 is separated with dioldehydratase and it is reproduced to a normal coenzyme B12 by reductase and other factors. Dioldehydratase and coenzyme B12 form a complex and catalyze the reaction again. PduS and FldA are known as bacterial reductase. PduS is

unstable under aerobic conditions, so the research team has studied whether PduS or FldA is better using enzyme activity measurement. We have purified PduS and FldA by constructing circular DNA which include *pduS* or *fldA* gene expressed by *Escherichia coli*. If a complete coenzyme B12 recycling system is recreated in vitro, this system could be applied to several enzymatic reactions which need coenzyme B12. My goal is determining reductase for coenzyme B12 recycling system.
Keywords: reductase, coenzyme B12, PduS, PduO, dioldehydratase