The 9th International Symposium on Materials in External Fields

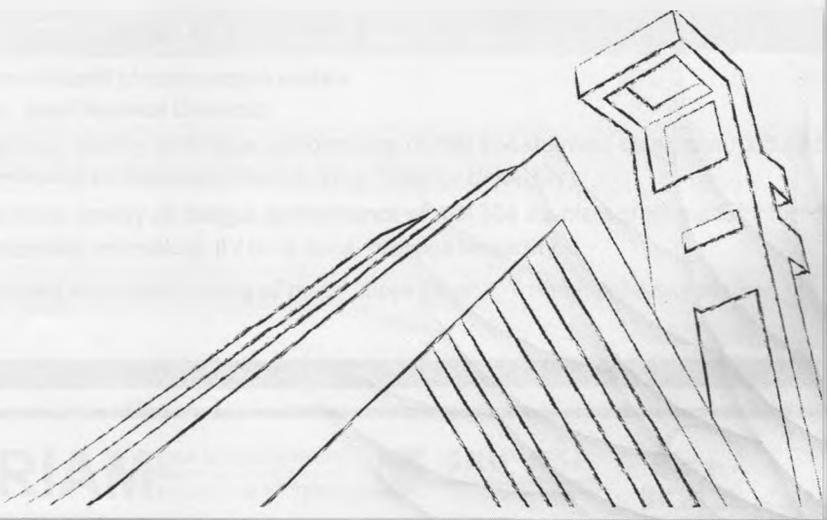
ISMEF 2018

Date

Sep. 2nd (Sunday) - Sep. 4th (Tuesday)

Venue

Room 513, Bldg. 38, Seoul National University
Seoul, South Korea



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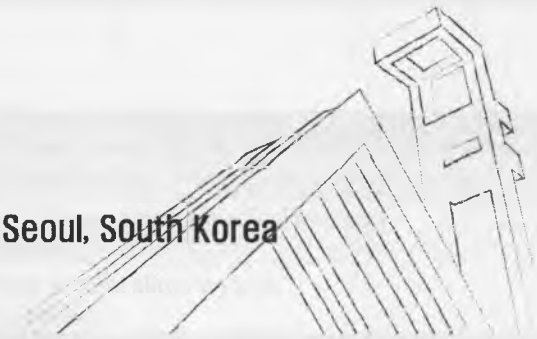

Date : Sep. 2nd (Sunday) – Sep. 4th (Tuesday)

Venue : Room 513, Bldg. 38, Seoul National University, Seoul, South Korea

DAY 1 | SEP. 2nd

18:00 ~	**Welcome Dinner for Foreign Participants** / Hoam faculty house

DAY 2 | SEP. 3rd ➢ 2018. 9. 3. 8:40 ~ 17:50

Time		Title / Speaker, Organization
08:00 ~	**Registration**	
08:40 ~ 08:50	**Opening Remark** / Prof. H.N. Han, Seoul National University	
08:50 ~ 09:00	**Welcome Remark** / Prof. D. Kwon, Seoul National University	
	Session 1 【Chair : Prof. Heung Nam Han】	
09:00 ~ 09:30	**Invited**	Electropulsing-induced structure regeneration in steels / Prof. R. Qin, Imperial College London/The Open University
09:30 ~ 10:00	**Invited**	Generation of charged nanoparticles in the gas phase and their deposition into thin films and nanostructures in CVD and PVD processes / Prof. N.M. Hwang, Seoul National University
10:00 ~ 10:30	**Invited**	Fatigue life of commercially pure titanium BT1-0 after pulse current treatment / Prof. S. V. Konovalov, Samara National Research University
10:30 ~ 10:50	**Tea Break**	
	Session 2 【Chair : Prof. Rongshan Qin】	
10:50 ~ 11:20	**Invited**	The effects of electric current on densification and microstructure of ceramic materials with different electrical conductivities during spark plasma sintering / Prof. C. Park, Seoul National University
11:20 ~ 11:50	**Invited**	Kinetic unmixing and decomposition of ternary oxides in external electric fields / Prof. M. Martin, RWTH Aachen University
11:50 ~ 12:20	**Invited**	Eectroexplosive nanocomposite coatings of contacts of switches of powerful electrical lines / Prof. D. A. Romanov, Siberian State Industrial University
12:20 ~ 12:30	**Group Photo**	
12:30 ~ 14:00	**Lunch** / Rakgujung, Bldg. 38, B1 floor	
	Session 3 【Chair : Prof. Chan Park】	
14:00 ~ 14:30	**Invited**	Electric current-induced phenomena in metals / Prof. H.N. Han, Seoul National University
14:30 ~ 15:00	**Invited**	Influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology I / Prof. G. Tang, Tsinghua University
15:00 ~ 15:30	**Invited**	Influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology II / Dr. G. Song, Tsinghua University
15:30 ~ 16:00	**Invited**	Electrically assisted solid state joining of metal alloys / Prof. S.-T. Hong, University of Ulsan
16:00 ~ 16:20	**Tea Break**	

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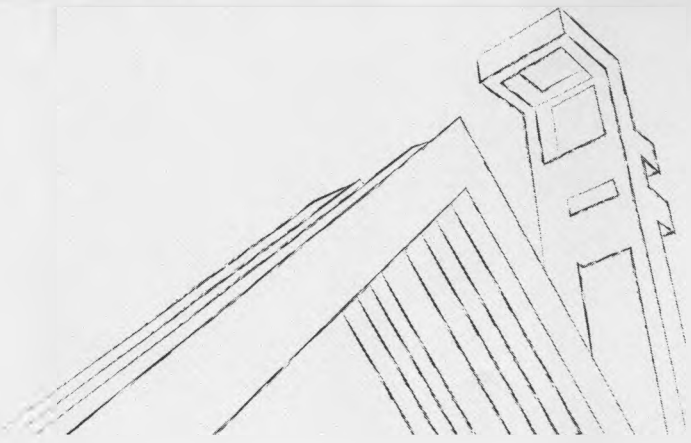
DAY 2 | SEP. 3rd ➢ 2018. 9. 3. 8:40 ~ 17:50

Time		Title / Speaker, Organization
		Session 4 【Chair : Prof. Sergey V. Konovalov】
16:20 ~ 16:50	**Invited**	Bio inert electrospray coatings of Ti-Nb and Ti-Zr systems for medical implants / Prof. K. V. Sosnin, Siberian State Industrial University
16:50 ~ 17:20	**Invited**	Atomistic simulation of cascade displacement in Ni-Al alloys system / Prof. M. D. Starostenkov, Altai State Technical University
17:20 ~ 17:35		Effect of surface environment on drawing deformation of AISI 1070 steel / Mr. D. Zhao, University of Science and Technology Beijing
17:35 ~ 17:50		A study on the improvement of tool life and surface quality in thermally assisted machining using multi-heat sources / Mr. W.-S. Woo, Changwon National University
17:50 ~	**Dinner** / Hoam faculty house	

DAY 3 | SEP. 4th ➢ 2018. 9. 4. 9:20 ~ 11:30

Time		Title / Speaker, Organization
		Session 5 【Chair : Prof. Sung-Tae Hong】
09:20 ~ 09:50	**Invited**	Electron beam induced crack controlling in metal thin film on soft substrate / Prof. I.-S. Choi, Seoul National University
09:50 ~ 10:20	**Invited**	Grain refinement in pure aluminium induced by applying electric current during solidification / Dr. M.-J. Kim, Korea Institute of Industrial Technology
10:20 ~ 10:35		Effects of electropulsing on formability of Fe-6.5wt.%Si wire / Mr. C. Han, University of Science and Technology Beijing
10:35 ~ 10:50		Investigation of the order – disorder transition in the bcc-alloys with complexes of antiphase boundaries during stepwise heating / Ms. A. A. Chaplygina, Altai State Technical University
10:50 ~ 11:05		An ultrafast performance regeneration of aged stainless steel by pulsed electric current / Mr. X. Liu, University of Science and Technology Beijing
11:05 ~ 11:20		The study on mechanical properties of Al-Y_2O_3 coatings formed on silumin by electroexplosive spraying / Mr. K. A. Osintsev, Siberian State Industrial University
11:20 ~ 11:30	**Closing Remark** / Prof. G. Tang, Tsinghua University	
11:30 ~	**Lunch** / Rakgujung, Bldg. 38, B1 floor	



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The 9th International Symposium on
Materials in External Fields

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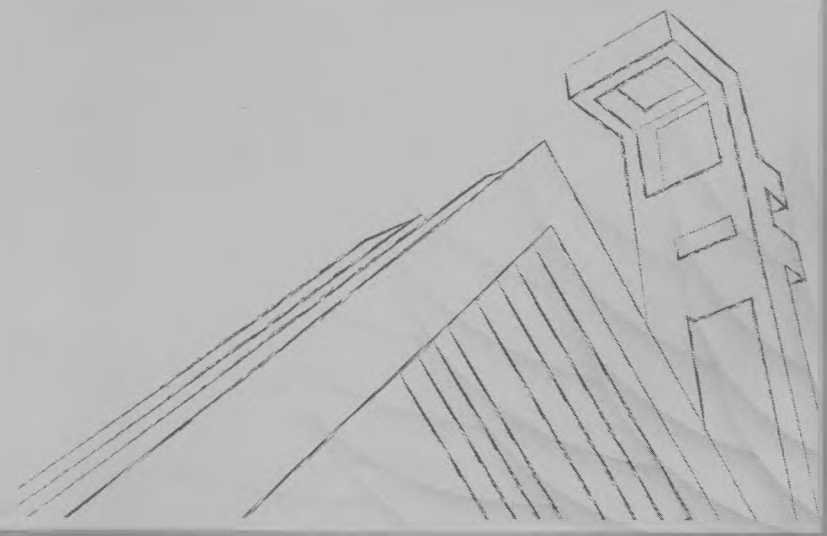
Session 1

Chair : Prof. Heung Nam Han

Electropulsing-induced structure regeneration in steels
Prof. ***R. Qin, Imperial College London/The Open University***

Generation of charged nanoparticles in the gas phase and their deposition into thin films and nanostructures in CVD and PVD processes
Prof. ***N.M. Hwang, Seoul National University***

Fatigue life of commercially pure titanium BT1-0 after pulse current treatment
Prof. ***S. V. Konovalov, Samara National Research University***



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Electropulsing-induced structure regeneration in steels

Rongshan Qin

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Abstract

Application of electropulsing to duplex stainless steel causes the aged microstructure and mechanical property regenerated. This phenomenon has been investigated by theoretical modelling, numerical calculation and experimental validation. An electromagnetic database has been established to support the generic design and treatment of steels microstructure. The electric current free energy has been integrated with thermodynamic database and phase field model to investigate the phenomenon. Potential application for power plant steels has been identified.

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Generation of Charged Nanoparticles in the Gas Phase and Their Deposition into Thin Films and Nanostructures in CVD and PVD Processes

Nong-Moon Hwang*

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Abstract

It has been believed that thin films grow by individual atoms or molecules, which land on the terrace, diffuse to the ledge and are finally crystallized at the kink of the growing surface. This terrace-ledge-kink (TLK) model, which can be called 'classical crystallization', has been known as a standard growth mechanism of crystals not only in solution but also in chemical or physical vapor deposition processes. Recently, however, extensive studies have been made on non-classical crystallization, which refers to the crystal growth by the building block of nanoparticles [1]. The crystal growth by the building block of nanoparticles was directly observed in-situ by transmission electron microscopy using a liquid-cell technique [2].

In parallel with the non-classical crystallization in solution, the non-classical crystallization in the gas phase synthesis of thin films and nanostructures by chemical vapor deposition (CVD) and some physical vapor deposition (PVD) has been studied extensively [3-5]. Here, the charged nanoparticles (CNPs) are spontaneously generated in the gas phase and become the building block of thin films and nanostructures. Charged nanoparticle-based crystallization appears to be very general, including the growth of diamond, Si, ZrO2, Si3N4, GaN, ZnO films as well as nanostructures such as nanowires and nanotubes. The generation of CNPs in the gas phase was experimentally confirmed in many systems and their mass distribution was shown to play a decisive role in the microstructure evolution of films, nanowires, and nanotubes [3-5].

The fact that CNPs can be a building block of crystals without leaving any void behind and of nanowires with smooth surface indicates that CNPs are quasi-solid, having a liquid-like property in diffusion. This means that the charge enhances the atomic diffusion, which is a newly discovered physical phenomenon. This means again that charge weakens the bond strength. Small nanoparticles can be liquid-like even if singly charged but large nanoparticles should be multiply charged to be liquid-like.

The liquid-like property of small CNPs can be understood by softening of positively and negatively CNPs generated in the CVD and some PVD processes. By controlling the size of CNPs, epitaxial or crystalline films could be deposited at low temperature [6-8]. Based on this new understanding of charge-enhanced kinetics, lots of fundamental studies and applications can be done.

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Fatigue life of commercially pure titanium BT1-0 after pulse current treatment

Konovalov S.V.[1,2*], Komissarova I.A.[1,3], Kosinov D.A.[1], Ivanov Yu.F.[4], Gromov V.E.[2]

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[2]Wuhan Textile University, 1 Fang Zhi Road, 430073, Wuhan, China
[3]Siberian State Industrial University, 42, Kirov str., 654007, Russia
[4]Institute of high current electronics SB RAS, 2/36 Akademichesky Avenue, Tomsk 634055, Russia

Fatigue failure of metals and alloys as a process evolving over time locally in materials is characterized by gradual accumulation of defects under the cyclic load. This load deteriorates the service life of work pieces because of crack formation and fracture if a certain critical state reached. This paper reports on treatment using strong current pulses to recover physical and mechanical properties of samples of commercially pure titanium BT1-0.

The samples treated with pulse current at a particular phase of fatigue testing were analyzed. The fracture surface was studied using the method of scanning electron microscopy (Tesla BS-301).

As a result of pulse current treatment of samples in the mid-stage of fatigue testing the fatigue life increases by ≈1.3 times, as compared with the samples fractured without current.

Electron-microscopic studies on the defect sub-structure of fractured samples of commercially pure titanium BT1-0 were carried out. It was revealed that a sub-microcrystalline structure with average crystallites of 422.7 nm is formed in the surface layer with a thickness up to 10 μm after fatigue testing.

The sizes of crystallites in the surface layer rose manyfold in the samples of commercially pure titanium BT1-0 after pulse current treatment when fatigue testing.

The structure of the surface layer is characterized by the quasi equiaxed form of grains and relatively high dimensional dispersion of grains (the sizes are 0.1 – 2.1 μm). As assumed, the reason for it is recrystallization process of the material taking place when pulse current treatment. Some flexural extinction contours were identified in the surface layer of the fractured samples. It indicates relaxation of elastic stress in the surface layer of material. The micro-diffraction analysis revealed particles of oxide phase in the surface layer of titanium samples after pulse current treatment. The particles are on boundaries of grains and sub-grains of α - titanium. The oxide particles vary from 10 nm to 35 nm; that is substantially bigger in comparison with oxide particles in the surface layer of titanium tested without pulse current treatment. The identified effects are possible, since pulse current treatment conditions relaxation of elastic stress, and sizes of grain and sub-grain structure in the surface layer of titanium and oxide phase particles increase manyfold.

This work was financially supported by the state tasks no. 3.1283.2017/4.6 to perform research work, RFBR research projects No. 17-32-50003_mol_nr and 16-32-60048 mol_a_dk.

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The 9th International Symposium on
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Session 2

Chair : Prof. Rongshan Qin

The effects of electric current on densification and microstructure of ceramic materials with different electrical conductivities during spark plasma sintering
*Prof. **C. Park, Seoul National University***

Kinetic unmixing and decomposition of ternary oxides in external electric fields
*Prof. **M. Martin, RWTH Aachen University***

Eectroexplosive nanocomposite coatings of contacts of switches of powerful electrical lines
*Prof. **D. A. Romanov, Siberian State Industrial University***

The 9th International Symposium on Materials in External Fields (ISMEF 2018)

The effects of electric current on densification and microstructure of ceramic materials with different electrical conductivities during spark plasma sintering

Jonghun Ryu[1], Jun-young Cho[1], Siyar Muhammad[1], Rita Galvez[1], Woochan Jin[1], Chan Park[1,2,*]

[1]Department of Materials Science and Engineering, Seoul National University, Seoul 08826, Republic of Korea
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Abstract

Spark plasma sintering (SPS), which uses both electric current and uniaxial pressure, has been widely used to consolidate various materials with relatively high density and limited grain growth within a very short time compared to conventional sintering methods. A large number of studies on the densification of materials using SPS and the effects of electric current during sintering of metals which have high electrical conductivities have been reported. The effects of electric current during SPS of ceramic materials most of which have smaller electrical conductivities than metals, however, is still not fully understood. In this study, the densification and the change of microstructure of two ceramic materials with different electrical conductivities (one has higher electrical conductivity than the other) were studied by comparing the results of SPS and hot pressing (HP) under the same pressure and temperature. A special attention was given to the accurate measurement of the temperature of the materials being sintered. The comparison of the microstructure and properties of the two ceramic materials which were spark plasma sintered and hot pressed will be presented, and the effect of electrical current on the sintering of materials with small electrical conductivities will be discussed.

The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Kinetic unmixing and decomposition of ternary oxides in external electric fields

Manfred Martin[1,2*], Jakyu Chun[2], Han-Ill-Yoo[3]

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[2] Department of Materials Science and Engineering, Seoul National University, Korea
[3] Daegu Gyeonbuk Institute of Science & Technology, Daegu, Korea

Abstract In a uniform oxygen activity atmosphere, cation electrotransport induces a ternary or higher oxide, e.g., ABO_3, to kinetically unmix unless the electrochemical mobilities of the cations are identical. Once the extent of unmixing exceeds the stability range of the ternary oxide it will kinetically decompose into the component oxides AO and BO_2. Here, we report experimental results on $NiTiO_3$ and $BaTiO_3$ showing kinetic decomposition and no decomposition as well. We also derive novel theoretical expressions for the kinetic decomposition voltage U_{kin} and compare with experimental values

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The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Eectroexplosive nanocomposite coatings of contacts of switches of powerful electrical lines

Romanov D.A.[1*], Moskovskii S.V.[1], Gromov V.E.[1]

[1] Siberian State University of Industry, Russia, e-mail: romanov_da@physics.sibsiu.ru

Abstract. The present work carried out within the general direction of development of scientific research and practical developments – surface protection by spraying coatings using concentrated energy flows. The aim of the work is the formation of electroerosion-resistant coatings by the method of electroexplosive coating and subsequent electron-beam processing, study of their structure, phase composition and properties. The coatings will be investigated using the following equipment: an optical microscope, a scanning electron microscope, a transmission electron microscope, an X-ray diffractometer, an optical interferometer. The coatings will be tested for wear resistance and electroerosion resistance, nano-hardness. As a result of the project, the physical nature of the formation of the structure and properties of electroexplosive electroerosion-resistant composite coating of Ag-CuO system after electron-beam processing will be established. The results obtained in this project will serve as a stimulus for further research in the field of electro-explosive coating and electron beam treatment of electroerosion resistant coatings. Analytical review of information sources, in particular, patent research on the subject of the project; an analysis of Russian and foreign scientific and technical periodicals over the past two decades; a comparative evaluation of effectiveness and a substantiation of the choice of the optimal variant of the research direction. Electro-explosive electroerosion-resistant coating of Ag-CuO system will be formed on copper electrical contacts of switches of powerful electric lines of various nomenclature. Electron-beam modification will be carried out over a wide range of beam parameters (energy density 10-40 J / cm^2, duration and number of pulses 50-200 microseconds and 1-50), which will allow to reduce the degree of roughness, to increase hardness, wear resistance, erosion resistance, to homogenize the volume of electro-explosive electroerosion-resistant coating of Ag-CuO system on copper electrical contacts of switches of powerful electrical lines of various nomenclature. The methods of electron scanning and transmission microscopy and X-ray phase analysis will be used to study the phase and elemental composition, the state of the defective substructure (type, size and morphology of phases, amplitude of internal stress fields, parameters of dislocation substructure) of electroerosion resistant coatings formed by the method of electro-explosive coating and subsequent electron- beam processing. Electroerosion resistance, microhardness and wear resistance of composite coatings formed by the method of electro-explosive coating and subsequent electron beam treatment will be tested. The optimal (from the point of view of the structural-phase states and the results of the tests of electro-erosion resistance, microhardness and wear resistance) is the electron-beam modification of electro-explosive coatings on the surface of copper electrical contacts of switches of powerful electrical lines.

The study was supported by a grant from the Russian Science Foundation (project no. 18-79-00013).

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Session 3

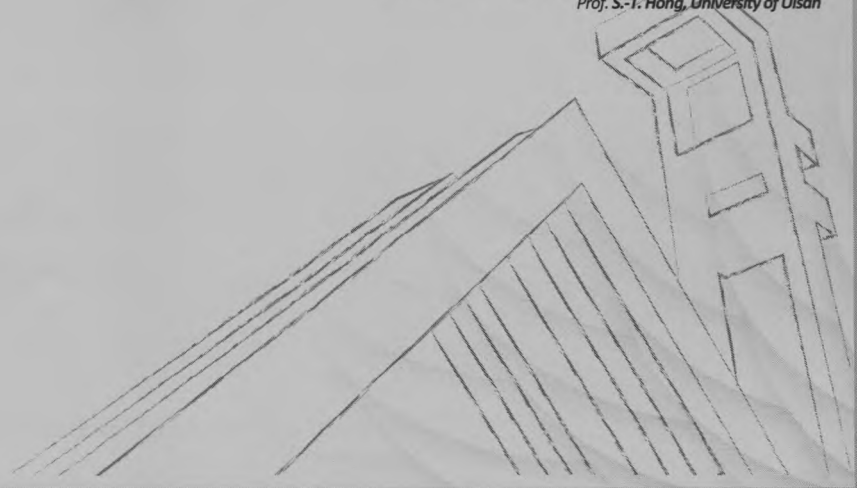
Chair : Prof. Chan Park

Electric current-induced phenomena in metals
Prof. ***H.N. Han, Seoul National University***

Influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology I
Prof. ***G. Tang, Tsinghua University***

Influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology II
Dr. ***G. Song, Tsinghua University***

Electrically assisted solid state joining of metal alloys
Prof. ***S.-T. Hong, University of Ulsan***



The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Electric Current-induced Phenomena in Metals

Heung Nam Han[1*], Moon-Jo Kim[2], Sang-Moon Yoon[1], Siwook Park[1], Hye-Jin Jeong[1], Ju-Won Park[1], In-Suk Choi[1], Sung-Tae Hong[3], Seung Hyun Cho[4], Young-Kyun Kwon[5], and Miyoung Kim[1]

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[4]Korea Research Institute of Standards and Science, Deajeon 34113, South Korea
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Abstract

Recently, various studies on marvellous effect of electric current on metallic materials have been actively reported. One of them is electroplasticity, which indicates that the elongation increased drastically with softening of flow stress during deformation under electric current. In addition, it has been reported that kinetic enhancements were obviously observed in microstructural changes such as dislocation annihilation, aging, dissolution, and recrystallization in metal metallic materials. Thus, applying the electric current could be utilized as a new process parameter in materials manufacturing.

In the library, there are various hypotheses, which include Joule heating, electron wind, and magnetic induction effects, on the mechanism of electric current-induced phenomena. However, these cannot account for all microstructural change in metallic materials under electric current. It is still controversial how the electric current enhances atomic diffusion.

In this talk, the marvellous effects of electric current on the deformation behaviour and microstructural change in various metallic materials will be presented. It will also be experimentally proven that these phenomena are due to the effect of the electric current itself, which is quite different from that of Joule heating. Finally, the origin of electric current-induced phenomena including electroplasticity will be discussed on the basis of a measurement of elastic constant, an atomistic simulation and a finite element modelling under electric current.

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The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology

Haibo Wang[1], Guolin Song (presenter)[1], Guoyi Tang (presenter)[1*]

[1] Advanced Materials Institute, Graduate School at Shenzhen, Tsinghua University, Shenzhen 518055, PR China

Abstract

The influence of surface quality on fatigue performance of AISI 304 stainless steel manufactured by various processing technology was systematically investigated in the current study. By taking the conventional turning product as a control, subsequent mechanical polishing and electropulsing-assisted ultrasonic surface rolling process (EP-USRP) were carried out on AISI 304 stainless steel, respectively. As a result, different surface qualities were obtained, and corresponding fatigue performance showed inspiring results. The researches indicate that EP-USRP can produce a higher average rotating bending fatigue strength (ARBFS) for AISI 304 stainless steel compared to turning and mechanical polishing. For the control sample treated by turning, the ARBFS is 263 MPa. For mechanical polished sample, it is 368.8 MPa, showing a 40.2% improvement. This is only due to the reduction of surface roughness, from Ra 1.2 μm of turning sample to Ra 0.2 μm of mechanical polishing one. Although the sample treated by EP-USRP shows an identical surface roughness of Ra 0.2 μm as the turning sample has, its ARBFS increases to 593.5 MPa, showing a 61% and 125.7% improvement compared to the mechanical polished and turning-treated samples, respectively. In addition to the extremely low surface roughness, super-high hardness, formation of nano-gradient microstructure and great compressive residual stress induced by EP-USRP within the surface strengthening layer are the main reasons for the significant enhancement of the fatigue performance. Anomalously and noteworthily, all fatigue specimens treated by EP-USRP showed an incomplete fracture, revealing a higher reservation of security in practical engineering applications.

Keywords: AISI 304 stainless steel; Electropulsing-assisted ultrasonic surface rolling process; Fatigue performance; Surface roughness; Ultra-refined grain; Residual compressive stress

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The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Electrically Assisted Solid State Joining of Metal Alloys

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[2] School of Automotive Engineering, Shanghai University of Engineering Science, Shanghai, China
[3] Department of Materials Science & Engineering and Center for Iron & Steel Research, RIAM, Seoul National University, Seoul, South Korea

Abstract

Two different concepts of electrically assisted solid state joining of various metal alloys are experimentally demonstrated. Firstly, electrically assisted pressure joining of cylindrical 316L stainless steel specimens are attempted using resistance heating as a heat source. By directly applying an electric current to a specimen assembly under continuous axial compression, defect-free joints are successfully fabricated. Also, it is demonstrated that a lower joining pressure can be achieved by using an additive manufactured porous interlayer with a lower compressive strength and higher electric resistivity between joining specimens. In the electrically assisted pressure joining using the porous interlayer, microstructural analysis confirms that the porosity is eliminated and recrystallization occurred in the interlayer. Secondly, electrically assisted pressure joining of grade 1 titanium (Ti) alloy sheets is attempted in a lap joint configuration. In joining, an electric current is also directly applied to the joining sheets during plastic compression. Microstructural analysis confirms that solid-state joints are successfully fabricated in the selected Ti alloy sheets without melting. Mechanical tests of the lap joint shows that the strength and fracture mode of the joint are strongly affected by a combination of the amount of plastic deformation and the electric current intensity. The result of mechanical tests also shows that an optimal thickness reduction corresponding to the maximum fracture load, can be found for a given current intensity. Also, the concept of electrically assisted pressure joining is confirmed to be applicable to a high entropy alloy.

Keyword: electrically assisted; solid-state joining; stainless steel, titanium alloy; high entropy alloy

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The 9th International Symposium on Materials in External Fields

ISMEF 2018

Session 4

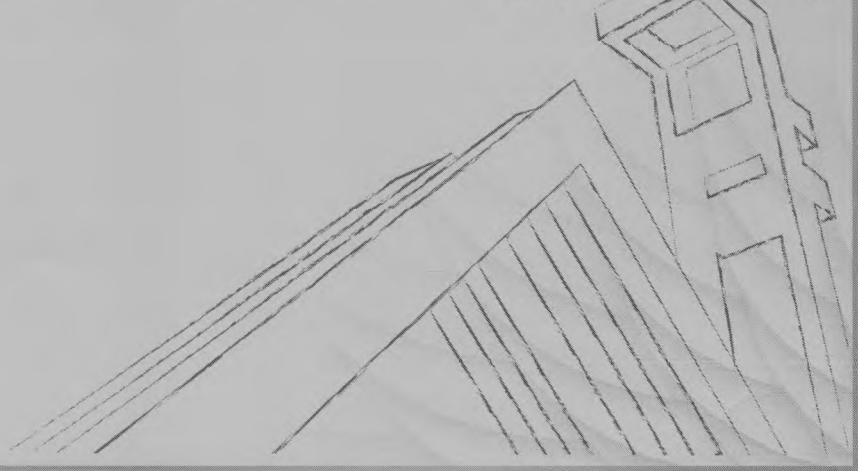
Chair : Prof. Sergey V. Konovalov

Bio inert electrospray coatings of Ti-Nb and Ti-Zr systems for medical implants
*Prof. **K. V. Sosnin, Siberian State Industrial University***

Atomistic simulation of cascade displacement in Ni-Al alloys system
*Prof. **M. D. Starostenkov, Altai State Technical University***

Effect of surface environment on drawing deformation of AISI 1070 steel
*Mr. **D. Zhao, University of Science and Technology Beijing***

A study on the improvement of tool life and surface quality in thermally assisted machining using multi-heat sources
*Mr. **W.-S. Woo, Changwon National University***



The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Bio inert electrospray coatings of Ti-Nb and Ti-Zr systems for medical implants

Sosnin K.V.[1*], Romanov D.A.[1], Gromov V.E.[1]

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Abstract. At present, medical implants are actively used for implantation into the body in the case of prostheses, or as an identifier. Investigation of physico-chemical and morphological properties, structure of implants is one of the priority problems of condensed matter physics and medical material science. The scientific novelty of scientific research is that the electric-explosion treatment of the titanium alloy proposed for use will make it possible to form bio-inert coatings of Ti-Nb and Ti-Zr systems on its surface. This will radically change the structural and phase state of the titanium implant, create bioinert nanostructured coatings with a low modulus of elasticity on its surface. As a result of the project, scientific and innovative products will be developed - a titanium implant protected by electric explosive coatings of Ti-Nb and Ti-Zr systems. The developed implant will have properties superior to those currently used.

The study was supported by a grant from the Russian Foundation for Basic Research (project no. 18-32-00075 mol_a).

The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Atomistic simulation of cascade displacement in Ni-Al alloys system

Starostenkov M.D.[1]*, Trung N.T.H[2], Phuong H.S.M[2]

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Abstract

Molecular dynamics simulation was employed to investigate the irradiation damage properties of Ni-Al alloys system. To enable molecular dynamics simulation of high energy collisions, a new many body potential was developed by joining the equilibrium part of Mishin EAM potential for Ni-Al system with the universal function of Biersack and Ziegler (ZBL potential) at a suitable interatomic spacing and corresponding pairwise energy from DFT calculation. By using this modified potential we have performed MD simulations of 1-40 keV displacement cascades in B2 NiAl and $L1_2$ Ni_3Al at different temperature. The evolution of displacement cascades, number of the created point defects, the cascade efficiency the clustering of point defects, and temperature role of these parameters at different PKA energies were systematic investigated. We observed the strong dependence of the threshold displacement energy E_d and clustering defect distribution on the crystallographic direction. It is found that the effect of temperature on defect production is small and the number of stable Frenkel pairs production are in good agreement with many reports from literature and it can be fitted in power law function of PKA energy.

Keyword: *molecular dynamics, irradiation damage, displacement cascades, Frenkel pair, clustering defect, threshold displacement energy.*

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The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Effect of surface environment on drawing deformation of AISI 1070 steel

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Abstract

Surface environment promoting plastic deformation of materials has been reported in literature. This effect, which can be named as chemomechanical effect, can be applied to cold-drawing for a hard and brittle material. In this work we studied the cold drawing of high carbon steel under an electrochemical environment in order to understand the softening mechanism.

Cold drawing of AISI 1070 high carbon steel was performed in either traditional lubricants or acid solution. Anodic polarization was applied to some of the steel in the acid solution. The results show that the anodic polarization on the sample surface can significantly improve surface quality and enhance workability of the high carbon steel. The variation of the drawing force with the drawing passes for the electrochemical and traditional drawing were quite different. The phenomenon indicated that the anodic polarization can much decrease the work hardening effect during the deformation. This implies that piled up dislocations can be shifted by the chemomechanical effect.

Key words: Drawing deformation, Anodic polarization, Chemomechanical effect.

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The 9th International Symposium on Materials in External Fields (ISMEF 2018)

A study on the improvement of tool life and surface quality in thermally assisted machining using multi-heat sources

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Abstract

Thermally assisted machining (TAM) is evaluated as an effective method to enhance the machinability of the hard-to-cut materials by an external heat source. Many researchers have been performing studies on the machining characteristics including tool life and surface quality by TAM using the single heat source but it is still unclear whether tool life will be improved, compared to conventional machining. TAM using multi-heat sources is newly introduced as TAM method of the hard-to-cut material to improve the machinability. Therefore, this paper investigates tool life and surface quality during conventional machining, TAM using single heat source and multi-heat sources (laser, induction, and laser and induction). Thermal analysis using laser heat source and induction heat source were carried out, and experiments were performed under the same material removal rate (MRR). And, optimal heating sequence and machining conditions are proposed to reduce thermal effect and improve tool life and surface quality. Heating sequence, the laser following the induction or the induction following the laser, is important for tool life and surface quality. The combination of laser and induction is shown to improve the tool life as compared with the single heat source.

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Session 5

Chair : Prof. Sung-Tae Hong

Electron beam induced crack controlling in metal thin film on soft substrate
Prof. ***I.-S. Choi, Seoul National University***

Grain refinement in pure aluminium induced by applying electric current during solidification
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Effects of electropulsing on formability of Fe-6.5wt.%Si wire
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Investigation of the order - disorder transition in the bcc-alloys with complexes of antiphase boundaries during stepwise heating
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An ultrafast performance regeneration of aged stainless steel by pulsed electric current
Mr. ***X. Liu, University of Science and Technology Beijing***

The study on mechanical properties of Al-Y_2O_3 coatings formed on silumin by electroexplosive spraying
Mr. ***K. A. Osintsev, Siberian State Industrial University***

The 9th International Symposium on Materials in External Fields (ISMEF 2018)

Electron beam induced crack controlling in metal thin film on soft substrate

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Abstract

When electrons are injected into materials on the nanoscale, their wave–particle duality leads to interesting electron–material interactions. Electronic kinetic energy is transferred to the materials by electron scattering, which can break or recombine atomic bonds in the materials and generate secondary electrons in the materials while they can also be transmitted through the materials, depending on the size and properties of the materials and the kinetic energy of the electrons. Here, guided by Monte Carlo Simulations, we systematically modulate the electron-beam (e-beam) energy at which electrons can be transmitted through a Cu nanofilm but can interact with a polyimide (PI) substrate underneath the Cu film. This transmitted e-beam modified the interface between the Cu thin film and the PI substrate without damaging or changing the e-beam bombarded Cu film, resulting in controlled crack formation in the Cu thin film during stretching.

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Grain refinement in pure aluminium induced by applying electric current during solidification

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Abstract

In recent years, high performance alloy plays an important role in automobile industry. The application of lightweight materials such as aluminium or magnesium alloy can reduce the weight of vehicles and energy consumption by improving energy efficiency. Also, as the safety standards become stricter, the property of lightweight materials must be guaranteed or improved. Therefore, research of high-performance alloys becomes an important issue in both academic and industrial field.

Various techniques have been applied for enhancing the strength of alloys, such as the solid-solution strengthening, precipitation strengthening, strain hardening and grain refinement, etc. Especially, grain refinement during solidification has been suggested effective method for improving property of metal. Different approaches to achieve microstructure with fine grains have been suggested, such as adding grain refiner, ultrasonic vibration, electromagnetic vibration, electromagnetic stirring, and electric current (EC) technique.

In the EC technique, electric current is applied to molten metal during solidification. In some previous researches, it has been reported that EC technique can refine the grain structure, when electric current is applied during solidification process. However, the mechanism of grain refinement by EC technique is still unclear.

In this research, solidification of pure aluminium under high density of electric current is investigated based on microstructural analysis. For insulation, a sand mold is used and two parallel electrodes are located at the melt surface. To analysis the cooling curve, k-type thermocouple was inserted at the different height along the vertical axis of the mold. The value of applied electric current and time are set as variables for experiment. Microstructure in the longitudinal section of the solidified samples are observed based on optical microscopy (OM) and scanning electron microscopy (SEM). Also, characteristic of grain refinement is studied considering cooling curve during solidification. Then, the effect of electric current on grain refinement for pure aluminium is discussed based on experimental results.

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Effects of electropulsing on formability of Fe-6.5wt.%Si wire

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Abstract

Fe-6.5wt.%Si alloy is a kind of soft magnetic materials with nearly zero magnetostriction, high relative permeability, low coercive force and iron loss. People could manufacture transformers by coiling silicon steel wires around a copper conductor. Yang et al. had obtained Fe-6.5wt.%Si wires with 1.0 mm in diameter through hot drawing already. However, Fe-6.5wt.%Si alloy is hard to deform at room temperature due to its low formability. Yet cold drawing will provide good mechanical and magnetic properties for ultrathin wires. External electro-pulsing can be employed to enhance the formability.

The electroplastic effect in Fe-6.5wt%Si wire was studied through tensile deformation. It was found that electropulsing increased the fracture elongation dramatically and reduced the strength in comparison to the non-electropulsing sample. Air cooling was applied during the deformation process to keep the surface temperature rise below 30°C in order to minimize the joule heating effect. The improved plasticity can be attributed to the enhancement of the dislocations movability. This study provided a promising way to fabricate high silicon steel wire at room temperature.

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Investigation of the order – disorder transition in the bcc-alloys with complexes of antiphase boundaries during stepwise heating

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Abstract

Using a mono-nickel aluminide (NiAl) and β-brass (CuZn) as an example, the influence of APB complexes (a pair of shear APBs along the <110> direction and a pair of APBs along the <100>direction) on the low-stability pre-transitional states of BCC-intermetallic compounds is investigated by the Monte Carlo method. It is shown that in the region of the low-stability states of this compound the formation energy of a complex of thermal APBs is higher than that of a complex of shear APBs. The contribution of APBs into disordering is essential up to the structural-phase transformation temperature. The most significant factor for the long-range ordering in the system is the appearance of a defect in the form of an APB itself, while the differences in the APB types and planes of their occurrence do not so essentially affect the long-range order behavior with the temperature variations. A system with structural defects is obviously less ordered compared to a defect-free system. The presence of a defect in the form of an APB promotes disordering of the system at lower temperatures: the degree of ordering starts to decrease in the case of thermal APBs at a lower temperature compared to the case of shear APBs. In the NiAl alloy with a complex of <100> APBs, the first distortions of the structural order invariably appear near the Al–Al boundary. In the CuZn alloy with a complex of thermal APBs along the <100> direction the first distortions of the structural order invariably appear near the Zn–Zn boundary. In the alloys with a complex of shear <110> APBs, the distortions of the structural order are observed only in the regions where the boundaries cross. The presence of antiphase boundaries affects the alloy stability during heating. It is shown that the process of disordering is accompanied by smearing of the boundaries and their faceting.

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An ultrafast performance regeneration of aged stainless steel by pulsed electric current

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It has been proved thermodynamically that the dissolution of the precipitates is directly related to the temperature, that is, if the critical temperature cannot be reached, the precipitates can only grow and the precipitation process continues. Therefore, the reverse thermodynamic dissolution behavior of the precipitates under certain conditions will become very significant. Here we provide a new pathway to investigate the dissolution behavior of highly thermally stable precipitates under electropulsing. Our findings show that the change of free energy caused by the difference in electrical conductivities between the precipitates and matrix leads to the inverse thermodynamic precipitates' dissolution.

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The study on mechanical properties of Al-Y_2O_3 coatings formed on silumin by electroexplosive spraying

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To date, aluminum alloys, including silumin, are critically important in all industries. Products manufactured of silumin are integral parts of mechanisms where high mechanical and physical characteristics are strongly required. The method of electroexplosive alloying used for processing the material surface enhances manifold its strength and tribological properties; on the other hand, the specific weight of a product is low. The coatings formed this way have good adhesion with the substrate and high functional properties [1-2]. The coatings are sprayed by a drop-plasma stream, formed under electrical explosion of a current-conducting foil with a weighted portion of a powder material.

In the reported study aluminum foil was used as a current-conducting foil and yttrium oxide powder as a weighted portion of a powder material. Two spraying procedures were selected for three different weights of a powder portion. A discharge voltage of coaxial electrodes was 2.6 kV in the first procedure, and coatings were formed due to the transformation of silumin surface layers into the pre-melting state, furthering this way homogeneous mixing of explosion products with the substrate material. In the second procedure a discharge voltage was 2.8 kV, as a result, surface layers were melted and particles of a plasma jet penetrated the material matrix.

To investigate mechanical parameters of the coatings some research into the resistance of a diamond pyramid penetrated into the material (Vickers micro-indention) and tribological studies were carried out. The study of tribological properties of the modified silumin layer involved determination of its wear resistance and friction coefficient.

As revealed, micro-hardness is maximal in the coating and exceeds that of silumin in the initial state more than two times. The farther from the modified surface, the lower is micro-hardness, being equal to that of the initial material at a depth of approximately 90 μm. In accordance with the tribological tests wear resistance of the material after electroexplosive alloying is 28 times higher as compared with silumin in the initial state, the friction coefficient decreased more than twofold.

Therefore, electroexplosive alloying of silumin with particles of yttrium oxide powder results in formation of a surface layer, mechanical (micro-hardness) and tribological (wear resistance and friction coefficient) properties of which are significantly higher than respective characteristics of silumin in as-cast condition.

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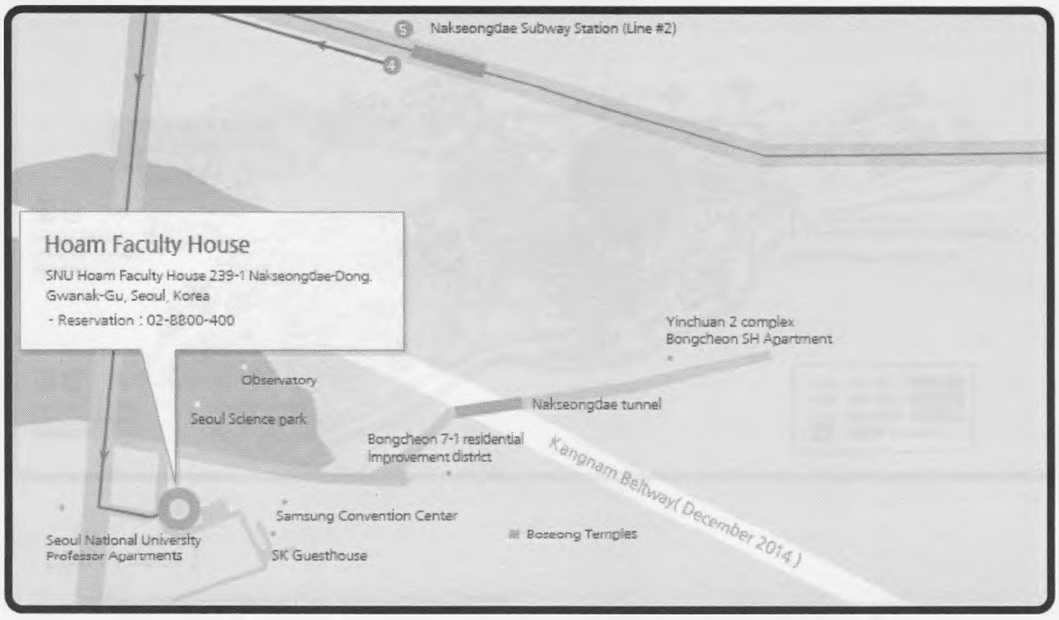
Map & Contact

· Hoam Faculty House



· Way #1 From Incheon airport to Hoam

1. Take the "#6017 Airport limousine bus" at the GATE 27(Terminal 2) or GATE 6B(Terminal 1)
2. Get off at the last stop "Hoam Faculty House"

· Way #2. From Gimpo airport to Hoam

1. Take the "#6003 Airport limousine bus" at the Bus terminal #6. The bus will depart every 20minutes. The bus fare is 4,000 won by cash.
2. Get off at the main gate of Seoul National University. Take a taxi or a shuttle from the main gate of Seoul National University
   - Shuttle service is available upon reservation only.
   - Running hour of shuttle : 08:00~18:00 (Monday to Friday).
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-	Incheon Airpot → HFH	Gimpo Airpot → HFH
FARE	75,000 won	30,000 won
-	Everyday	-

2. The fare could be changeable upon traffic situation. Please contact us at +82-2-880-0311 or front@hoam.ac.kr for reservation