ALMA Forum 2018

Abstracts of Presentations
& Poster Session

10 November, 2018

Shibaura Institute of Technology Toyosu Campus,

Toyosu, Koto-ku, Tokyo Japan

Japan Institute of Light Metals

ALMA Forum 2018

Program

Date: 10 November, 2018
Venue: Shibaura Institute of Technology Toyosu Campus, Toyosu, Koto-ku, Tokyo Japan

Opening Ceremony

Chairperson: Prof. Masahiro Kubota (Nihon University, the International Communication Committee of Japan Institute of Light Metals, Japan)

9:00 *Opening Address*

Prof. Yoshihito Kawamura (Kumamoto University, Chair of ALMA and Chair of International Communication Committee of Japan Institute of Light Metals, Japan)

Session 1

Chairperson: Prof. Kwang Seon Shin (Seoul National University, Korea)

9:05 *Including sustainability in the design of aluminium alloys for light-weighting*

Prof. Malcolm Couper (Monash University, Australia)

9:35 *Current Situation and Countermeasures of Bauxite Resources in China*

Dr. Lijuan Qi (Zhengzhou Nonferrous Metals Research Institute Co., Ltd. of CHALCO, China)

10:05 *Technical Issues of Titanium and Aluminum Alloys for Transportation Vehicles Applications in Korea*

Dr. Jong-Taek Yeom (Korea Institute of Materials Science, Korea)

10:35 Coffee Break & Poster session (10:35 – 10:45)

Session 2

Chairperson: Asst. Prof. Cheng-Yu Wang (National Chiao Tung University, Taiwan)

10:45 *An Overview of Taiwan's Titanium Industry*

Dr. Yeong-Tsuen Pan (China Steel Corp., Taiwan)

11:15 *Magnesium as an Energy Carrier*

Dr. Isao Nakatsugawa (National Institute of Advanced Industrial Science and Technology, Japan)

11:45 *Magnesium Alloys for Hydrogen Storage*

Prof. Yuri Estrin (Monash University, Australia)

12:15 Lunch (12:15 – 13:15)

Poster Session

13:30 *Effect of Long-period Stacking Ordered Phase on Hot Tearing Susceptibility of Mg-Zn-Y Alloys*

Prof. Pingli Mao (Shenyang University of Technology, China)

Microstructure Evolution of AZ31 Magnesium Alloy during Continuous Extrusion and Hot Rolling Processes

Assoc. Prof. Lili Guo (Dalian Jiaotong University, China)

Session 3

Chairperson: Prof. Malcolm Couper (Monash University, Australia)

15:10 *Progress of the Research and Development of Chinese Magnesium Alloy Materials on New Energy Vehicless*

Prof. Pingli Mao (Shenyang University of Technology, China)

15:40 *Status of Magnesium Research and Development in Korea*

Prof. Kwang Seon Shin (Seoul National University, Korea)

16:10 *Development of Heat Treatable Magnesium-Lithium Alloys*

Asst. Prof. Cheng-Yu Wang (National Chiao Tung University, Taiwan)

16:40 *Present State of Japanese Aluminum Industries*

Dr. Mitsuhiro Otaki (Japan Aluminium Association)

Closing Ceremony

Chairperson: Dr. Zenya Ashitaka (Toyo Aluminium K.K , Vice Chair of the International Communication Committee of Japan Institute of Light Metals, Japan)

17:20 *Honoring Ceremony and Group Photo*

17:50 *Closing Address*

Mr. Toshiya Anami (Nippon Light Metal Co.,Ltd, Vice Chair of the International Communication Committee of Japan Institute of Light Metals, Japan)

Including sustainability in the design of aluminium alloys for light-weighting

Malcolm J. Couper
Department of Materials Science and Engineering, Monash University, Clayton 3800, Australia

According to the Australian Aluminium Council [1], in 2017, Australia remained the largest bauxite producer (82Mt), the second largest alumina producer (21Mt) and produced 1.6Mt of aluminium. The aluminium production has reduced recently with smelter closures and the secondary metal market has also adjusted to the closure of rolling capacity and public pressure to recycle waste. Over the last 30 years globally, the production of semi-fabricated aluminium (rolled, extruded, cast products) from recycled metal has only managed to keep pace with the growth of semi's from primary metal in the ratio 30:70.

Given the current imperatives for energy reduction and sustainability [2], it is now essential that alloy developments not only meet demands for light-weighting to reduce fuel use, but also include designing for recycling, both for closed loop use of new scrap and end-of-life old scrap. This presentation considers 6xxx alloy design with a particular focus on the consequences for processing, quality, composition and performance of alloys that are made with a significant proportion of recycled metal or scrap [3].

[1] M. Prosser, "Australian Aluminium in a Global Context", Proceedings of the 6th Australasian Aluminium Extrusion Conference (AAEC), Melbourne, 10-12 September 2018, Ed. B. Rinderer.
[2] H. Helms, J. Kraeck, "Energy Savings by Light-Weighting – 2016 Update", IFEU study commissioned by the International Aluminium Institute and European Aluminium.
[3] S. Capuzi, G. Timelli, "Preparation and Melting of Aluminium Scrap in Recycling: A Review", Metals 2018, *8*, 249.

Malcolm J. Couper

Adjunct Professor at Department of Materials Science and Engineering, Monash University, Clayton VIC 3800, Australia

Email address: malcolm.couper@monash.edu

Professor Malcolm Couper completed a B.Sc.(Hons) in Physics, then a Ph.D.(Eng.Sc.) and Post-Doctoral Fellowship in Materials Engineering at Monash University, Australia. From 1983 to 1989 he was Research scientist and Project leader with Asea Brown Boveri (ABB) in Switzerland. From 1989 to 2009 he managed various R&D and Technology activities within Rio Tinto Aluminium, Australia. He has championed a number of new product ideas from fundamental research, through development and commercialization. These have included powder metallurgy, metal matrix composites, semi-solid and conventional aluminium materials as described in conference publications and journal papers (136) and patents (14).

His career in industry has been complemented with University appointments as Research Coordinator ARC Centre of Excellence for Design of Light Metals, Adjunct Professor positions (University of Queensland, Monash University, Chongqing University) and lecturing at Melbourne University, Monash University, Central South University and Hunan University. He was Director and National President of the Institute of Materials Engineering Australasia Ltd. from 2011-13 and has held a number of Technical and Management advisory roles in collaborative R&D activities in Australia and accreditation activities for Engineers Australia.

Current Situation and Countermeasures of Bauxite Resources in China

Lijuan Qi Qingjie Zhao
Zhengzhou Nonferrous Metals Research Institute Co., Ltd. of CHALCO

In this talk we specify the quantity and quality of bauxite resources and analyze the effects of the present situation of bauxite resources in China on the future production cost, product quality and development layout of alumina industry. The amount and grade of diasporic bauxite used in the present alumina industry have been decreased with the rapid development of alumina industry in China, which has caused the great increases of bauxite and caustic soda consumption, also reduced the alumina quality problems, such as lithium, potassium and zinc etc. The report also puts forward the measures to deal with the current situation of bauxite resources in China and the key technologies that need to be solved urgently in the future. Importing bauxite from abroad is one way to solve the above problems, but trying to make better use of diasporic bauxite at home is more important for China. A series of new technologies have been developed to make better use of low grade diasporic bauxite, such as hydro-series process, chemical desilication process, and new bayer-sintering series process as well, some of the processes have been tested industrially, and some have been applied in the alumina plant. The researches on the lithium removal and recycle from alumina are being investigated, and the studies on the potassium and zinc removal in the alumina are also being carried out.

Lijuan Qi

Senior Engineer at Department of Alumina, Zhengzhou Non-ferrous Metals Research Institute Co., Ltd of CHALCO

Email address:lijuanqi2002@163.com

Dr. Qi received her Ph.D. degree from the Department of Physical Engineering at Zhengzhou University, China. She has been with Zhengzhou Non-ferrous Metals Research Institute Co., Ltd of Chalco(Aluminum Corporation of China) for more than 17 years since her graduation from Northeastern University as a postgraduate, and now she is served as a senior engineer in the Department of alumina. In 2015, she was assigned as the Association Head of Alumina Department in Zhengzhou Non-ferrous Metals Research Institute Co., Ltd of Chalco.

Her research field involves the two fields, hydrometallurgy and energy conservation as well. She studied the new processes of alumina production from low grade diasporic bauxite and non-bauxite Al-Containing resources such as coal flash and andalusite, energy saving in the alumina production, impurity removal from hydrate alumina. She has been studying the valuable matters recovered in the alumina production, such as lithium, potassium, and sodium oxalate as well, and also the improvement of systematic efficiency for the alumina production.

Technical Issues of Titanium and Aluminum Alloys for Transportation Vehicles Applications in Korea

Jong-Taek Yeom
Advanced Metals Division, Korea Institute of Materials Science, 797 Changwondaero Seongsangu, Changwon 51508, Korea

Lightweight metal materials have been used in transportation vehicles such as aircraft and automobiles. In particular, demand for titanium alloys with high specific strength is increasing in order to maximize the weight saving effect of aircraft. In the domestic aviation industry, the technical issues of aluminum materials are to develop new alloys and new manufacturing processes to compete with carbon composites. The technical issues of titanium materials are to revitalize the domestic market of titanium alloy materials and components for aviation and to foster global component makers. In order to activate the domestic aerospace industry in the future, the development of light metals such as titanium and aluminum materials should be preceded.

In this presentation, the global market and development trends of aluminum and titanium materials will be discussed first in the transportation vehicles applications, especially in aviation industry. Next, we will discuss on the development of lightweight metal materials, especially titanium materials and its components, developed in Korea for aviation applications. Finally, we will deal with strategies for developing lightweight metals and its components in the domestic aviation industry.

Jong-Taek Yeom

Principal Researcher at Titanium Department, Advanced Metals Division,
Korea Institute of Materials Science

Email address:yjt96@kims.re.kr

Principal researcher Jong-Taek Yeom has made significant and exorbitant contributions to the alloy design and thermos-mechanical processing of titanium alloys, through numerous research and development activities in the past two decades. He obtained his master degree in Materials Science and Engineering from Hongik University in 1996. After receiving his master degree, he joined Korea Institute of Materials Science(KIMS) as researcher, and later promoted to senior researcher in 2001, principal researcher in 2011, a post he still holds today. From 1999 to 2000, he was a visiting researcher at Rolls-Royce Co. in U.K. During his stay to Rolls-Royce, he conducted material analysis and life prediction studies on aviation materials, particularly titanium and nickel alloys. He obtained his Ph. D. degree in Materials Science and Engineering from Pohang University of Science and Technology(POSTECH) in 2008.

His work in the field of titanium alloys include the following:

(1) Development of high strength and excellent toughness titanium alloys
(2) Plastic forming processes of CP-titanium and titanium alloys
(3) Microstructure control technology of titanium alloys
(4) Thermomechanical processing of CP-titanium and titanium alloys
(5) Shape Memory alloys and titanium-base superelastic materials

His research has been published in more than 100 research papers in materials science and engineering.

He has also played important roles in the scientific and professional communities to promote research and technology, such as the Editor and councilor of the Korean Institute of Metals and Materials, the Editor of the Scientific World Journal in Hindawi Publishing Corporation, “Materials Science”, and a Member of the Korean Society for Technology of Plasticity.

An Overview of Taiwan's Titanium Industry

Yeong-Tsuen Pan
Manager, Specialty Alloy Development Section,
New Materials R&D Dept., China Steel Corp., Taiwan

The Titanium industry in Taiwan is booming in recent years, mainly attributed to the shift back of golf clubs business and the massive use of Titanium consumer products. In 2017, around 5700 MT Titanium was imported (Top 11 in the world) and 1500 MT Titanium was exported. The Titanium industry in Taiwan can be categorized into three major fields including golf club business, aerospace & biomedical business, and industry & consumer business. Concerning the production of golf club products, the VAR skull melting practice was widely used in Taiwan for the production of Titanium golf club head castings. Whereas, the Titanium alloy plates for golf club head are all imported. Taiwan is the sixth most-attractive country of aerospace manufacturing in the world ranked by PWC. The strong machining capability for Titanium aerospace parts, mainly for the fan and low and high-pressure compressor of the airplane engine, contributes to such attractiveness. However, the Titanium raw materials for aerospace parts including castings, forgings, plates, bars, and tubes are all imported. The Titanium raw materials for biomedical applications such as artificial joints and dental implants exhibited the same situation as aerospace Titanium materials by 2003. Such a dilemma was breached when S-Tech corp. (STC), Taiwan, launched to produce the bio-medical Titanium bars and got the certificates from Stryker and JMM in 2006. Industry & consumer application is another emerging Titanium business in Taiwan. STC also produces the Titanium products for the industry & consumer applications but is confined to long products due to the constraint of rolling facilities. To fill the lack of flat products for industry & consumer applications, China Steel Corp. (CSC), Taiwan, established a subsidiary company (CSPM) to produce the Titanium VAR slabs and blooms in China, which are shipped back and co-rolled using the existing steel rolling facilities in CSC to produce plates, strips and bars for industry & consumer applications, such as petrochemical tanks, electrolytic anode, tank for electrodeposited copper foil, smartphone & racing car fasteners, consumer ware, and architecture etc. since 2011. Taiwan also devoted to producing the Titanium powders for additive manufacturing by using plasma wire atomization and crucible-free gas atomization technology. There is no Titanium tube manufacturing business in Taiwan.

Yeong-Tsuen Pan

Manager, Specialty Alloy Development Section,
New Materials R&D Dept., China Steel Corp., Taiwan

Email address:t112@mail.csc.com.tw

Dr. Yeong-Tsuen Pan received his Ph.D. degree from the Department of Materials Engineering at National Sun-Yet Sen University, Taiwan. He joined Steel R&D Dept., China Steel Corp., Taiwan, in 1985. He was a visiting researcher at the Department of Mechanical Engineering in University of Waterloo, Canada, from 1992 to 1993.

By 2011, his main research fields focused on the development of hot rolled high strength and low alloy steels for automobiles and the alloy design of stainless steels. In 2011, he moved to New Materials R&D Dept. and was in charge of the development of specialty alloys, including Ti alloys, Ni-base alloys, and target materials. By integrating the production of Ti Slab (China Steel Precision Materials in China), Hot rolling facilities (China Steel Corp. in Taiwan), and Annealing & Pickling and cold rolling facilities (Stainless Steel Production Companies in Taiwan), various China Steel Corp.'s Titanium products, including heavy plates, HR and CR strips, and bar & rod products, were launched into the market.

Magnesium as an Energy Carrier

Isao Nakatsugawa
National Institute of Advanced Industrial Science and Technology, Japan

1. Magnesium as an energy carrier

Energy carrier is a chemical substance that serves for energy transport and storage. While current mainstream energy carriers are fossil fuels, carriers for renewable energy such as hydrogen or methanol are attracting attention. Since Magnesium (Mg) is chemically active, lightweight and present in large amounts in the sea and crust, it is expected to work as a solid energy carrier. The potential of electricity and hydrogen carrier is discussed here.

2. Use as electricity carrier

Mg has a negative electrode potential of -2.37 V and a Faradaic capacity of 2.205 Ah/g, which is attractive for battery anodes.

<u>Primary battery:</u> Traditional dry batteries with MnO_2 cathodes were popular in military applications till the 1970s. Water-activated Mg batteries with metal or MnO_2 cathodes are used for undersea devices or the emergency signals. Mg-air batteries (MABs) have attracted attention as small-to-middle sized power supplies for emergency or outdoor purposes. As atmospheric oxygen acts as a reactant, MABs can generate electricity until the Mg anode is exhausted. The accumulation of discharge product $Mg(OH)_2$, hydrogen evolution on the Mg anode and the resultant low efficiency of about 60% is a challenge for wider applications.

<u>Secondary battery:</u> Mg anode is inexpensive, does not form dendrite during charging process. Lower cell voltage, sluggish electrode kinetics and the formation of a poor conductive film impede the competition with LIB.

3. Use as hydrogen carrier

While Mg absorbs 7.6 wt% of hydrogen, the application for hydrogen storage materials remains in the stage of R&D. A major obstacle is its high desorption temperature above 300 deg.C. A process of extracting hydrogen by the hydrolysis of MgH_2 to supply fuel cell cathodes is developed. As the reaction produces $Mg(OH)_2$ irreversibly, the following regeneration is mandatory.

4. Reuse and regeneration of $Mg(OH)_2$

MgO and $Mg(OH)_2$ are currently used as refractory materials, gas desulfurizing agent, and cement materials. To utilize Mg as an energy carrier, it is necessary to establish a cost-effective regeneration cycle to metallic Mg. In place of current Pigeon process which uses fossil fuel, electric reduction system using ceramic membrane or hydrogen plasma is being proposed.

Isao Nakatsugawa

Senior Research Scientist at Light Metal Design Group, Structural Materials Research institute, National Institute of Advanced Industrial Science and Technology (AIST), Japan

Email address:i.nakatsugawa@aist.go.jp

Dr. Isao Nakatsugawa received his engineering degree from the Department of Material Science and Chemical Engineering at Yokohama National University, Japan. After working as an invited researcher at Ecole Polytechnique of Montreal, he joined Institute of Magnesium Technology, Canada for five years. He accumulated industrial/academic experiences through working at The Japan Steel Works, Foxconn Technology, Hokkaido University, and venture companies. He joined AIST since 2017.

Magnesium electrochemistry, especially in the field of corrosion and surface treatment, is his life-long R&D theme. In recent years, he is also perusing a possibility of Mg as an energy carrier, which he will talk today.

Magnesium Alloys for Hydrogen Storage

Yuri Estrin
Department of Materials Science and Engineering, Monash University, Clayton 3800, Australia
Department of Mechanical Engineering, The University of Western Australia, Crawley WA6009, Australia

A high hydrogen storage capacity of magnesium has been attracting the attention of researchers for a long time. A particular target has been their use for automotive applications. However, a high hydrogen release temperature is an obstacle to such applications. Attempts to reduce this temperature below the desired level of 200ºC have been unsuccessful. In our work, we explored an approach based on nanostructuring of Mg alloys by severe plastic deformation (SPD) [1], which changes both the kinetics and the thermodynamics of hydrogen storage. In this talk a short overview of the results obtained by SPD treatment of alloy ZK60 and a series of Mg-Ni alloys by equal channel angular pressing (ECAP) [2-4] will be reported, along with some more recent data. Such processing produces a reasonably stable non-equilibrium microstructure characterized by ultrafine grains, enhanced vacancy concentration, and excess volume. These factors induce thermodynamic shifts in a desired way and lead to accelerated hydrogen storage kinetics. This concept has been later adopted by other researchers who have applied it to a range of Mg alloys. A summary of research in this field and an outlook for future applications will be given in the talk.

[1] V.M. Skripnyuk, E. Rabkin, Y. Estrin, R. Lapovok, Acta Mater. 52 (2004) 405.
[2]V.M. Skripnyuk, E. Buchman, E. Rabkin, Y. Estrin, M. Popov, S. Jorgensen, J. Alloys Comp. 436 (2007) 99.
[3] V.M. Skripnyuk, E. Rabkin, Y. Estrin, R. Lapovok, Int. J. Hydrogen Energy. 34 (2009) 6320.
[4] L. Popilevsky et al., Int. J. Hydrogen Energy. 38 (2013) 12103.

Yuri Estrin

Professor at Department of Materials Science and Engineering,
Monash University, Clayton VIC 3800, Australia

Email address: yuri.estrin@monash.edu

Professor Yuri Estrin received a PhD degree from the Institute of Crystallography of the Academy of Sciences of the USSR. From 1979 on he held several professorial appointments in Germany and Australia. Currently he is an Honorary Professor in the Department of Materials Science and Engineering of Monash University, Melbourne and an adjunct Professor in the Department of Mechanical Engineering of the University of Western Australia in Perth. His research interests include mechanism-based constitutive modelling of strength and plasticity, bulk nanomaterials, materials for permanent and biodegradable implants, and geometry-inspired design of materials. He is the author of over 500 refereed papers and his h-index according to ISI Web of Science is 55.

For his research, Professor Estrin received numerous international awards, including an Alexander von Humboldt Award (2000 and 2012), an Honorary Doctorate from the Russian Academy of Sciences (2009), Full Membership in the Australian Academy of Science (2013), the Staudinger-Durrer lectureship award from the Swiss Federal Institute of Technology (ETH Zurich) (2011), the Helmholtz International Fellow Award (2014), the Thomson-Reuter Citation Award (2015) and an Honorary Membership of the German Materials Society.

Effect of Long-Period Stacking Ordered Phase on Hot Tearing Susceptibility of Mg-Zn-Y Alloys

Pingli Mao
School of Materials Science and Engineering,
Shenyang University of Technology

Due to the low density, high specific stiffness and corrosion resistance, magnesium (Mg) alloys have been widely used in aerospace, automobile and electronic industry. However, their industrial and commercial applications have been limited by the wide solidification temperature range and a considerable tendency of hot tearing. Understanding of the hot tearing susceptibility (HTS) of magnesium alloys is necessary for its industrial and commercial value. Mg-Zn-Y ternary alloys attracted intensive attentions due to the variety of the phases generated in the alloys according to the Zn/Y ratio. when Zn/Y>1, Zn/Y ≈ 1, Zn/Y< 1, the precipitated phase of alloys are I phase (or I phase and W phase), W phase (or W phase and small amount of I phase) and long-period stacking ordered (LPSO) phase (or small amount of W phase), respectively. As a specific strengthen phase, LPSO have been studied by many researchers. However, the hot tearing susceptibility of Mg-Zn-Y alloys with LPSO phase was not reported so far.

The effect of long-period stacking ordered (LPSO) phase on hot tearing susceptibility (HTS) of Mg-Zn-Y system alloys and the influence of Zn / Y ratio on Mg-Zn-Y system alloys were investigated experimentally using a home-made T-type hot tearing apparatus. The characteristic parameters related to HTS during the solidification process were measured by cooling curve thermal analysis. The microstructure and the morphology of crack zone were characterized by scanning electron microscopy (SEM) and Electron Back Scatter Diffraction (EBSD), and the composition of alloys was analyzed by X-ray diffraction (XRD). The result shows that LPSO phase formed when Zn/Y<1, and the amount of LPSO phase increase with Y increasing. LPSO phase could benefit refilling process during the solidification and decrease the HTS of Mg-Zn-Y system alloys. High Zn/Y ratio exhibits low HTS.

Pingli Mao

Professor at School of Materials Science and Engineering, Shenyang University of Technology

Email address:maopl@sut.edu.cn

Professor Mao received her bachelor degree with major of casting at 1991 from Harbin University of Science and Technology, her master degree with major of casting at 1996 from Shenyang University of Technology and her Ph.D. degree with major of materials processing engineering at 2002 from the Institute of Metal Research, Chinese Academy of Sciences. She has been a faculty of School of Materials Science and Engineering in Shenyang University of Technology. She had been working as a post-doctor at Florida State University, National High Magnetic Field Laboratory from 2005 to 2007. She was also a visiting Scholar at Florida State University, National High Magnetic Field Laboratory from January 2015 to June 2015. She has been a faulty of school of materials sciences and engineering in Shenyang University of Technology. Now she serve as a professor and was assigned as an academic leader of materials sciences in Shenyang University of Technology. She is the associate director of the key laboratory of magnesium alloys forming technology of Liaoning province.

Her research field mainly involves magnesium alloys design, fabrication and deformation, including: (1) investigation of high strain rates deformation and failure behavior and deformation mechanisms; (2) first principles calculation; (3) the design and fabrication of high performance magnesium alloy; (4) hot tearing behavior of magnesium alloys.

Up to now, she have been published at least 100 scientific papers, 18 Authorized invention patent of China and 1 Authorized invention patent of U.S.

She was awarded the Second Prize for Technological Invention of Liaoning Province at 2004, the Second Prize for Scientific and Technological Progress in Machinery Industry at 2010, the Third Prize for Scientific and Technological Progress of Liaoning Province at 2011. She has been a member of China Mechanical Engineering Associations, Material Branch, Magnesium Alloys Processing and Application Technology Strategic Alliance.

Microstructure Evolution of AZ31 Magnesium Alloy during Continuous Extrusion and Hot Rolling Processes

Lili Guo[1], Rong Fu[1], Jiuyang Pei[1], Junying Yang[1], Baoyun Song [2]
1. Engineering Research Center of Continuous Extrusion, Ministry of Education, Dalian Jiaotong University;
2. Dalian Konform Technical Company Limited

It is generally known that current available Mg alloy sheet are impractically expensive due to the complicated manufacturing processes. Therefore, the main challenge for application of the Mg sheet is to further reduce cost and improve the mechanical properties simultaneously. A new process, continuous extrusion technology combined with warm rolling, which could be used to produce the AZ31 Magnesium alloy sheets in lower cost was proposed in this study.

The continuous extrusion experiments were conducted by using TLJ400 machine under various processing conditions. As a result, the magnesium sheets in sizes of 160mm×8mm and 170mm×4mm were obtained successfully. Then, the sheets were rolled to approximate 1mm thickness at 350 and 200℃, respectively. The microstructure and texture evolution of the as-extruded and the rolled sheets were examined by using optical microscope and electron back scattered diffraction (EBSD). As a result, the microstructure in the center area of the continuous extruded sheet exhibited completed dynamic recrystallized grains with an average grain size of 12μm. However, a great number of coarse grains with an average grain size of 47μm were observed in the edge area. The microstructure of the final sheets could be refined and homogenized by rolling at a temperature of 200 ℃. On the other hand, macro-texture investigations were conducted by XRD. The results show that the (0002) basal intensity decreases from the center to the edge in the extruded sheet. $86.3° < 11\bar{2}0 >$ twin is a cause of weakening basal texture intensity in the edge region.

Tensile strength of the continuous extruded sheet is ranging from 218 MPa to 256 MPa, and the tensile elongation is in 9%~18% due to the inhomogeneous microstructures. However, the final sheet rolled at 200℃ temperature exhibits relative excellent tensile properties. The tensile strength reaches to 309MPa and the average elongation is about 18%.

Lili Guo

Associate professor at Engineering research center of continuous extrusion, Ministry of Education, Dalian Jiaotong University

Email address: guolili0822@hotmail.com

Dr. Guo Lili received her Ph.D. degree from the department of metallurgy, graduate school of engineering, Tohoku Univerisy, Japan, from Apr. 2008 to Mar. 2011. She was a scholarship student founded by Japanese Ministry of literature. Her Ph.D. thesis is “Influence of Rolling Conditions on Dynamic Recrystallization in AZ31 Magnesium Alloy”. She studied scanning electron microscopy with EBSD technique and charactrisation skills in Tohoku University, Japan. She returned Dalian Jiaotong Univeristy, china when she got her Ph.D degree in 2011. She has been a faculty member of the Engineering research center of continuous extrusion Ministry of Education at Dalian Jiaotong University, China.

During study aboard, she dedicated herself to several institutes in Japan, the Japan Society for Technology of Plasticity, the Japan Institute of Metals and Materials. After she returned china, she also participated in domestic or international academic conferences many times, such as, China Society for plastic processing, Youth magnesium alloy Conference and international conference on technology of plasticity (ICTP) in University of Cambridge in September 2017, and so on.

The research platform has accumulated over 30 years of theory and practice in metal extrusion field. It has a certain theoretical basis and rich practical experience in the continuous extrusion forming of copper and aluminum alloy. In recent years, many meaningful attempts and explorations have been performed by the team for forming the magnesium alloy sheets. The research field of Dr. Guo involves in light metals including magnesium alloys and aluminium alloys. She focused on the continuous extrusion and rolling processing of the magnesium alloys, microstructure and texture evolution, the mechanical properties & formability of the metals. Guo Lili, as one excellent researcher of the team is active in the research of low cost forming technology of magnesium alloys.

Progress of the Research and Development of Chinese Magnesium Alloy Materials on New Energy Vehicles

Wenfang Shi[1] **Huaiguo Wang**[1] **Pingli Mao**[2]
1. The Nonferrous Society of China 2.Shenyang University of Technology

When concerning with the energy resources conservation and environmental protection, low energy consumption and low emission automobiles are the control and key factors for the development of the economic society. There are two ways for the solution of the high energy consumption and emission, one is the development of new energy vehicle, and the other is the lightweight of the vehicle. So far, there are three methods to reduce the weight of the automobile. The first is to replace the existing materials with lighter materials. The second is to modify the structure by thinning the wall, miniaturizing and combining of the components. The third is to increase the application proportion of lightweight materials

As the lightest structure material, magnesium alloys have attracted much attention and been a research hot topic in the field of global materials and it had been proved that magnesium alloys are one of the most important choices for the lightweight materials used in the automobile industry. This report gives a brief introduction of the key achievements in the field of magnesium alloys development and application in recent years in China. Also the advantages and applications of magnesium alloy materials are analyzed and the newly developed technology of magnesium alloys and the synchronous design and development of typical components on new energy vehicles are summarized. During the developing and manufacturing process of magnesium alloy parts for the self-owned brand of new energy car, the involved technology including the automobile and parts design technology, simulation technology, new materials development and selection, the materials forming technology, such as casting, extrusion, rolling and forging, stamping and bent pipe, welding, riveting, bolt fastening and surface treatment technology, ect. The technologies developed were thoroughly validated through the microstructure observation and mechanical properties analysis of the magnesium alloy parts, and through the bench test and road test.

Wenfang Shi

Director of International Collaboration Department,
The Nonferrous Metals Society of China

Email address: wfshi@chinamg.org

Professor Wenfang Shi received her bachelor degree with major of metal materials at 1983 from Northeastern University, her master degree with major of management engineering at 1997 from Central South University. She has long engaged in organization and management of Chinese national technological projects in the field of new materials of nonferrous metals under the instruction of MoST(Ministry of Science and Technology).

As the person in charge of the project organizer, she has completed the implementation of dozens of projects related to nonferrous metals materials processing of China's "Tenth Five-year Plan", "Eleventh Five-year Plan" and "Twelfth Five-year Plan" since 1998, including "Chinese High-tech R&D Program(Program 863)", "National Sci-Tech Supporting Plan" and International Partnership for Nonferrous Metallurgy, Processing and New Materials of aluminum, copper, titanium, precious metals, refractory metals and rare-earth materials with America, Canada, Germany and EU.

Wenfang Shi served as the office director of "Development, Application and Industrialization of Magnesium Alloy" of "The Tenth Five-Year Plan". More than 400 thousand words were published with her professional papers and technical reports. She served as the editorial committee member of The Technology of Magnesium Alloy Preparation and Processing(2007) and The Domestic and Overseas Standard of Magnesium and Magnesium Alloy(2006). She served as the deputy secretary general of the organizing committee of 2004 and 2006 Beijing International Magnesium Conference. In addition, she has been invited many times to make special reports on both domestic and overseas international magnesium conferences, including 2007 America TMS conference and the Circum-HuangHai Region International Magnesium Seminar. She was also a former member of experts of program "the Technology Development of New Car Material"(1996-2001) and the national key project "the Electric Vehicle"(2001-2006). Now she is also a member of the materials committee of The Automotive Engineering Society of China.

Status of Magnesium Research and Development in Korea

Kwang Seon Shin
Magnesium Technology Innovation Center
Department of Materials Science and Engineering
Seoul National University
Seoul 08826, Korea

Magnesium alloys are the lightest structural metals, and have good physical and mechanical properties that make them extremely attractive for applications requiring lightweight materials. The global market for magnesium alloys has steadily expanded in the past decade, stimulated by the strong demand from the automobile and electronic industries for lightweight magnesium components.

In order to meet the demand of new high performance magnesium alloys and overcome technical challenges, there have been active research programs at a number of universities, national research institutes and industries to develop new magnesium alloys and processing technologies in Korea. This lecture will introduce the major magnesium R&D activities and recent research highlights in Korea.

The World Premier Materials (WPM) project on 'lightweight magnesium materials for transportation industry', which is the largest national R&D project on magnesium alloys in Korea, will be introduced with various outcomes achieved by the project. The research activities of the 'Magnesium Department' at the Korea Institute of Materials Science (KIMS) will also be introduced. These will include recent achievements in the area of (a) alloy development, (b) processing technology, and (c) practical applications. In addition, some of the research highlights at Korean universities will also be introduced in this lecture.

Kwang Seon Shin

Professor at Department of Materials Science and Engineering
College of Engineering, Seoul National University

Email address: ksshin@snu.ac.kr

Kwang Seon Shin received his B.S. from the Department of Metallurgical Engineering at Seoul National University (SNU) and his Ph.D. from the Department of Materials Science and Engineering at Northwestern University in the U.S.A. He became Assistant Professor in the Department of Materials Engineering in 1983 at Arizona State University in the U.S. In 1989, he was promoted to Associate Professor with tenure. Dr. Shin has been Professor of Material Science and Engineering at SNU since 1991.

Prof. Shin launched the research program on magnesium alloys at SNU and established the Magnesium Technology Innovation Center where he acts as Director. Prof. Shin acted as Vice President (2008~2009), and President (2013) of the Korean Institute of Metals and Materials (KIM), which is a technical society with more than 15,000 members. He started the Magnesium Committee at KIM and served as Chair (2007~2012).

Prof. Shin has been a member of the National Academy of Engineering of Korea since 2009. He was appointed as Chairman of the Korea Magnesium Technology Research Association (KMTRA) in 2014.

In 1995, Prof. Shin co-founded KIM's first English journal, 'Metals and Materials International (MMI)', and served as founding Editor (1995~2012). MMI gained international prestige in the field of metals and materials with an impact factor of 1.952. As Editor-in-Chief, he also played a vital role in registering the Korean Journal of Metals and Materials (KJMM), at the SCIE level with an impact factor of 1.518.

Prof. Shin's research focuses on the development, processing, and characterization of advanced structural materials, including magnesium, aluminum, and copper alloys. He is especially interested in the development of advanced processing technologies and high performance magnesium alloys with high strength, ductility, formability, and corrosion resistance.

Development of Heat Treatable Magnesium-Lithium Alloys

C.Y. Wang[*,1], P. T. Wu[2], J. Y. Wang[2]
*,1 Department of Materials Science and Engineering,
National Chiao Tung University
2 Department of Materials Science and Engineering,
National Dong Hwa University

Magnesium-lithium alloy can be applied in transportation and 3C products for its low density and promising damping traits. However, low recrystallization temperature leads to grain coursing and further sacrifices mechanical strength after hot working. It has been reported that mechanical property improvement can be done with aluminum addition via precipitation strengthening and solid solution strengthening mechanisms.

In this study, Mg-Li-Al-Zn alloy is investigated under different heat treatments. After hot rolling and solution treatment, the alloy was annealed under different cooling rate, including water quenching, air cooling, and furnace cooling. The as-rolled alloy shows ductile properties with ultimate tensile strengths (UTS) of 194 MPa and elongation 23% in the tensile tests. Similar UTS and elongation can be observed in the alloy after air and furnace cooling. Water quenched alloy, on the other hand, has improved UTS as 357 MPa but degraded elongation 12%.

In order to examine the strengthening mechanism, further characterizations of XRD, metallographic analysis, and hardness have been made. It is expected that precipitation of η phase of AlLi in alloys may improve UTS. However, it is found in the alloys after air or furnace cooling, with lowered UTS but enhanced elongation. No AlLi η phase is found in the water-quenched alloy. It is believed that water-quenched alloy improves the mechanical properties due to solid solution strengthening of Al in β (Li-rich) phase. The improved hardness of β (Li-rich) phase compared to α (Mg-rich) phase also supports the theory.

Cheng-Yu Wang

Assistant Professor at Department of Materials Science and Engineering,
College of Engineering, National Chiao Tung University

Email address: ChengYuWang@nctu.edu.tw

Dr. Cheng-Yu Wang received his Ph.D. degree from the Department of Energy and Mineral Engineering at the Pennsylvania State University, U.S.A. He begins his academic career as a faculty member of the Department of Materials Science and Engineering at Feng Chia University, Taiwan, and now he is the assistant professor of the Department of Materials Science and Engineering at National Chiao Tung University, Taiwan.

His research field involves materials for hydrogen energy, including porous materials metal-organic frameworks applied for hydrogen storage, and chemical/metal complex hydride for hydrogen generation. He has collaborations with Dr. Jian-Yih Wang at National Dong Hwa University on magnesium-lithium alloys.

Present State of Japanese Aluminum Industries

Mitsuhiro Otaki
Executive Advisor, Japan Aluminium Association

Since the original organization body was founded in 1947, we went through various consolidation and Japan aluminium Association (JAA) was formed in 1999. The main business activities of JAA are public relations, new demand & technology development, human resource development and statistics etc.

Utilizing the many advantages of aluminum and aluminum alloys as lightweight and high strength material, good workability, good thermal and/or electrical conductivity and ease of recycling etc, aluminum production in Japan has been maintained at over 4 million tons/year in recent years. In 2017, 4.258 million tons of aluminum products were mainly used for the transportation 41%, construction 12%, metal product 12%, food & beverage 10% by demand category in Japan. Rolled or extruded products are 49% and casting or die casting products are 34% by product category in Japan. Meanwhile, the production and consumption of aluminum in the world are increasing year by year. Especially the increase in China is remarkable.

JAA has been discussed about the future trends of aluminum technology and created a road map. As measures against global environment warming,
1) In products, reduction of weight of vehicle and acceleration of Electric vehicle for improving fuel economy
2) In manufacturing process, use of environmentally friendly primary aluminum ingot and promote of recycling
3) Towards resource saving, improvement of property by metallic structure control rather than chemical composition control
will be in a large trend in the aluminum industry.
Construction of recycling society should be necessary for future aluminum industry in Japan. It will be important to develop horizontally recycling with higher quality as product to product, not to depend on cascade recycling which is used as in the past.

Mitsuhiro Otaki

Executive Advisor, Japan Aluminium Association

Email address: m-ootaki@alkyo.jp

He was born in 1956. After graduating from faculty of Science and Engineering Waseda University, he received a doctorate in engineering from Graduate School of Science and Engineering, Waseda University. He joined Furukawa Electric Co., Ltd. in 1986 and engaged in research and development of melting, continuous casting technology of copper alloys and recycling technology of aluminum alloys. Then he engaged in research and development of DC casting technology of aluminum alloys at Furukawa-Sky Aluminum Corp., engaged in research of patent and technical information at Furukawa Research Inc., engaged in various academic societies activities including The Japan Institute of Light Metals (JILM) at UACJ Corporation. Currently he belongs to the Japan Aluminium Association.

He dedicates himself to several institutes in Japan; The Japan Institute of Light Metals, the Japan Institute of Metals and Materials, Japan Foundry Engineering Society, The Society of Automotive Engineers of Japan and Eco Material Forum.

In the Japan Institute of Light Metals, he was a member of Planning Committee, Conference Management Committee, General Affairs Committee and Sellection Committee for Takahashi Award. He was awarded JILM Light Metal Paper Prize and JILM Distinguished Service Medal.

In addition, he was awarded The Japan Institute of Metals and Materials paper prize, and Japan Foundry Engineering Society Kobayashi Prize.

His research and development field involves the melting, casting, solidification and recycling of copper alloys and aluminum alloys.