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2010 Fall Conference Abstracts

2010년도 대한금속·재료학회 추계 학술대회

초 록 집

■날짜 : 2010년 11월 4일(목)~5일(금)

■장소 : 창원컨벤션센터(CECO)

■주최 : (사)대한금속 · 재료학회

■주관 : 부산대학교

■후원 : • 한국과학기술단체총연합회
• POSCO
• 현대제철
• (주)R&B

사단법인 대 한 금 속 · 재 료 학 회
The Korean Institute of Metals and Materials

Break | 15:00~15:20

좌장 : 구양모(포항공과대학교)

중성자 및 방사광4-1 | 15:20

In-Situ Neutron Diffraction Study of Plastic Deformation in Magnesium Alloy

Soo Yeol Lee, Michael A. Gharghouri, John H. Root

National Research Council Canada.

중성자 및 방사광4-2 | 15:50

Study on the Microstructure and Crystallographic Texture Developments of Electroplated Thick Films by Using X-ray and Neutron Scattering Methods

*최용, 이종재, 이경배, 신은주[1], 성백석[1], 김만[2], 권식철[2], H. Inoue[3]

선문대학교. [1]한국원자력연구원. [2]재료연구소. [3]Osaka Prefecture University.

중성자 및 방사광4-3 | 16:20

Quantitative Phase Analysis of Martensite Phases in SUS430 steels by Neutron Diffraction

*성백석, 신은주, 박순동, 김성진, 이기홍, 채동철[1], 이윤용[1]

한국원자력연구원. [1]포스코기술연구원.

Room 301, November 4, Time 09:00-17:30

KIM-JIM Symposium

Chairman : Bong Su You/Yoshihito Kawamura

KJ1-1 | 09:10-09:35

Reversible Behavior of Deformation Twin in Pure Magnesium

Tomoki Kusaka, Takuya Suzu and Atsushi Yamamoto*

Graduate School of Engineering, University of Hyogo.

KJ1-2 | 09:35-10:00

Texture Development in Ca Containing Mg-Zn, Mg-Zn-Y and Mg-Zn-Al Alloys

J. S. Kyung, J. Y. Lee, J. G. Kim, W. T. Kim* and D. H. Kim

Dept. of Metallurgical Eng. Yonsei Univereity, *Dept. of Nanoscience, Chongju University.

KJ1-3 | 10:00-10:20

Atomic-scale Micostructure Analysis of Mg-Zn-Re Alloys by Advanced Electron Microscopy

Eiji Abe

Dept. of Materials Sci & Engg, University of Tokyo.

KJ1-4 | 10:20-10:40

Enhancement of Precipitation Hardening of Magnesium Alloys by Microalloying

K. Hono*, C. L. Mendis, K. Oh-ishi and J. Jayaraj

National Institute for Materials Science.

Break | 10:40-11:00

Chairmen : Hyo-Tae Jeong/Toshiji Mukai

KJ2-1 | 11:00-11:20

Nanocrystalline Mg-Zn-Y-Al Alloys with Long Period Stacking Ordered Structure

Yoshihito Kawamura*

Kumamoto University.

KJ2-2 | 11:20-11:40

Plastic Deformation Behavior of Long-period Stacking Ordered Phase Alloys

Koji Hagihara[1]*, Michiaki Yamasaki[2], Yoshihito Kawamura[2], Hiroyuki Y Yasuda[3]

[1]Department of Adaptive Machine Systems, Graduate School of Engineering, Osaka University, Japan [2]Department of Materials Science, Kumamoto University, Japan [3] Division of Materials and Manufacturing Science, Graduate School of Engineering, Osaka University.

KJ2-3 | 11:40-12:00

Plane Strain Compression Behavior of Magnesium Single Crystals

Ming-Zhe Bian, Kwang-Seon Shin*

Magnesium Technology Innovation Center, School of Materials Science and Engineering, Seoul National Universit.

Lunch | 12:00-13:30

Chairmen : Do Hyang Kim/Shigeharu Kamado

KJ3-1 | 13:30-13:50

Twinning Behavior of Mg Alloy - Effect of Stress Axis, Twin Interface Introduced by Pre-straining, Texture and Alloying Element

Seiji Miura

Hokkaido University.

KJ3-2 | 13:50-14:10

Texture Evolution of Mg Alloys

Hyo-Tae Jeong* and Byung-Hak Choe

Dept. of Advanced Metal and Materials Engineering, Gangneung-Wonju National University.

KJ3-3 | 14:10-14:30

Twin-Roll Casting of Mg Alloys - Opportunities and Challenges

J.H. Bae, D.W. Kim, B.C. Suh, M.-S. Shim, N.J. Kim

CAAM & GIFT, POSTECH.

KJ3-4 | 14:30-14:50

Microstructure and Mechanical Properties of Twin Roll Cast and Differential Speed Rolled Magnesium Alloy Sheet

S.B. Kang*, J.H. Cho, L.L. Chang

Korea Institute of Materials Science (KIMS).

KJ3-5 | 14:50-15:10

Quality Development of Mg Alloy Sheet Production in POSCO

*Oh-Duck Kwon, *Jong-Duck Park, **Woo-Jin Park, **D. Choo, *Sang-Ho Cho

*Magnesium business department of POSCO

**Magnesium flat product research project of RIST.

KJ3-6 | 15:10-15:30

Improving Mechanical Properties of Mg Alloys Using High-ratio Differential Speed Rolling

W. J. Kim
Dept. of Materials Science and Engineering, Hongik University.

Break | 15:30-15:50

Chairmen : Woo Jin Kim/K. Hono

KJ4-1 | 15:50-16:10

Development of High Strength Mg-Al-Ca-Mn Alloy by Extrusion

Shigeharu Kamado*, Tomoyuki Honma and Shiwei Xu
Nagaoka University of Technology.

KJ4-2 | 16:10-16:30

Indirect Extrusion of High Strength Mg Allos

Bong-Sun You*, Sung-Soo Park
Korea Institute of Materials Science (KIMS).

KJ4-3 | 16:30-16:50

Grain Refinement of Mg-Al-Zn Alloy by Repetitive Obilique Shear Strain

Toshiji Mukai*, Hidetoshi Somekawa, Alok Singh, Tadanobu Inoue
National Institute for Materials Science (NIMS).

KJ4-4 | 16:50-17:10

Effects of Zn Concentration on the Room Temperature Formability of Rolled Mg-Zn-Ce Alloys

Yasumasa Chino[1]*, Mamoru Mabuchi[2]
[1]National Institute of Advanced Industrial Science and Technology, [2]Kyoto University.

KJ4-5 | 17:10-17:30

Stud Welding of SC & Rolled Mg Sheet for IT Device Case

Mok-Young Lee
Research Institute of Industrial Science & Technology (RIST).

Room 302호, 11월 4일 09:00-12:15
구조재료 전사모사 심포지엄

좌장 : 박경수(POSCO기술연구원)

구조1-1 | 09:00 초청강연

Multiscale Numerical Approach for Transformation Plasticity in Steel

*한흥남, 조이길, 임영록[1], 김진유[1], 이재곤[1], 차필영[2], 서동우[3]
서울대학교. [1]포스코. [2]국민대학교. [3]포항공대 철강대학원.

구조1-2 | 09:30

싱크로트론 Tomography 분석과 연성파괴모델의 유한요소해석을 이용한 재료의 인장거동 시 연성파괴 해석

*김형섭, 윤은유, 서민홍[1], 유지훈[2], 주수현
POSTECH. [1]POSCO. [2]현대중공업.

구조1-3 | 09:45

A model of Goss Texture Formation in Secondary Recrystallization of Silicon Steel

Seong Gyoon KIM, Yong Bum PARK[1], Kyu Seok HAN[2], Jong Tae PARK[2]
Kunsan National University. [1]Sunchon National University. [2]POSCO.

구조1-4 | 10:00

Uniqueness of Goss orientation in Recrystallization Texture of Silicon Steel

Seong Gyoon KIM, Yong Bum PARK[1], Kyu Seok HAN[2], Jong Tae PARK[2]
Kunsan National University. [1]Sunchon National University. [2]POSCO.

Break | 10:15

좌장 : 한흥남(서울대학교)

구조2-1 | 10:30

The effect of Nb on the amount of retained austenite and strengthening in cold-rolled TRIP steels

*최종민, 박봉준, 이창연, 한성호[1], 이경종
한양대학교 신소재공학부. [1]POSCO 기술연구원 자동차소재연구그룹.

구조2-2 | 10:45

철강제품 및 프로세스의 전산모사 활용

*이재곤
포스코 기술연구원.

구조2-3 | 11:00

MatCalc를 이용한 오스테나이트계 내열강의 석출 거동 모사

*심재혁, Ernst Kozeschnik[1], 정우상, 조영환
한국과학기술연구원. [1]Vienna University of Technology.

구조2-4 | 11:15

Recent progress in atomistic simulations for structural materials

*이병주
포항공과대학교 신소재공학과.

구조2-5 | 11:30

Elastic Properties and Thermodynamics of bcc Ni_xFe_{1-x} From First-Principles

Gul Rahman, *김인기[1], H.K.D.H. Bhadeshia
GIFT. [1]POSTECH.

구조2-6 | 11:45 초청강연

Understanding Surface Nanostructures To Bulk Defects:An Ab Initio Thermodynamic Approach

*Aloysius Soon
Yonsei University.

Room 302호, 11월 4일 14:00-15:50
학회상 수상 기념강연

좌장 : 김목순(인하대학교)

수상강연1-1 | 14:00 청웅상 수상 기념강연

초고강도 고기능 구조용 소재의 개발동향 및 미래 응용분야

*배정찬
한국생산기술연구원.

KIM-JIM Symposium

Room 301호 November 4 Time: 09:00-17:30

[KJ1-1]

Reversible Behavior of Deformation Twin in Pure Magnesium: Tomoki Kusaka, Takuya Suzu and Atsushi Yamamoto; Graduate School of Engineering, University of Hyogo, Himeji, Hyogo 671-2201, Japan

Magnesium and its alloy sheets show the basal plane texture, in which (0001) plane is parallel to the rolled surface. In such a specimen, $\{10\bar{1}2\}$ type of deformation twins is favorably formed when compression stress is applied in the direction parallel to the rolling direction, while the twins are unfavorably formed under tensile stress in the same direction. Asymmetry in stress-strain curves in fatigue deformation would be attributed to this anisotropy in twinning. A small bending device for SEM-EBSD system has been developed by the authors, which enables one to apply compression or tension on the specimen surface depending on the direction of bending. Specimens were prepared from a commercial pure magnesium ingot. The same area in the specimen was observed with SEM-EBSD method. When compression stress was applied to the specimen, many deformation twins with $\{10\bar{1}2\}$ type were observed. The twins remained after unloading. All the twins disappeared under tensile straining. Twinning-detwinning was observed for three cycles of alternate compression-tension loading. Reversible behavior would be a intrinsic property for deformation twin in magnesium and its alloys. *Keywords*: SEM-EBSD, deformation twin, detwinning

[KJ1-2]

Texture Development in Ca Containing Mg-Zn, Mg-Zn-Y and Mg-Zn-Al Alloys: J. S. Kyung, J. Y. Lee, J. G. Kim, W. T. Kim and D. H. Kim; Dept. of Metallurgical Eng. Yonsei Univereity, Seoul, Korea. Department of Nanoscience, Chongju University, Cheongju, Korea

Keywords: Ma-ZnCa, Mg-Zn-Y-Ca, texture, formability

Magnesium alloys are known to have various characteristics such as high specific strength and stiffness, good shock absorbability and good electric/magnetic shielding capacity. Due to these advantages, the application of magnesium alloys has good prospect particularly in automobile industry in the forms of casting and wrought products. In the case of wrought products, the prime concern has been to enhance the formability. Therefore, it has been well established that a proper texture development is very important for enhanced formability in Mg-based wrought alloys. In the present study, we report effect of Ca addition on the texture development in Mg-Zn, Mg-Zn-Y and Mg-Zn-Al alloys. Basically, Ca containing Mg-Zn and Mg-Zn-Y alloys exhibits a strong non-basal texture development when compared with other Mg-based alloys, thereby exhibits a significantly improved formability. Annealing of Mg-Zn-Ca and Mg-Zn-Y-Ca rolled sheets leads to a significantly suppression of basal texture, indicating that inhomogeneous recrystallization plays an important role in alleviating the basal texture developed during rolling process. However, increase of Al in Mg-Zn-Ca alloy shows an adverse effect in suppression of basal texture after annealing treatment. Such an unusual texture development will be discussed from the several different points of view including the effect of secondary solidification phase particles and/or the effect of solute content in alpha Mg matrix.

[KJ1-3]

Atomic-scale Mocrostructure Analysis of Mg-Zn-Re Alloys by Advanced Electron Microscopy: Eiji Abe; Dept. of Materials Sci & Engg, University of Tokyo, Tokyo 113-8656, Japan

Keywords: magnesium alloys, long-period structures, electron microscopy, atomic-scale analysis

Mg alloys containing a small amount of Zn and RE (RE: Y and rare-earth atoms), e.g., $Mg_{97}Zn_1RE_2$ (at.%) alloys reveal excellent mechanical properties with high yield strength over than ~500MPa and elongations better than ~3% at room temperature. One of the key microstructural features is formation of a novel type of long-period ordered (LPO) structure, which is long-period chemical-ordered as well as stacking-ordered. There exist several stacking polytypes denoted as 18R, 14H, 10H, 24R, all of which are composed of a common structural unit represented by local ABCA stacking where B- and C-layers are significantly enriched by Zn and RE atoms. Using the state-of-the-art scanning transmission electron microscopy (STEM), we will describe details of the LPO structures by focusing particularly on the local Zn/RE order in the structure. We further discuss energetic origins of the LPO phase with the aid of first-principle calculations (VASP).

[KJ1-4]

Enhancement of Percipitation Hardening of Magnesium Alloys by Microalloying: K. Hono, C. L. Mendis, K. Oh-ishi and J. Jayaraj; National Institute for Materials Science, 1-2-1 Sengen, Tsukuba 305-0047, Japan

Keywords: wrought magnesium alloys, percipitation hardening

Research interest in age hardenable magnesium alloys has been recently revived because of increasing demand for weight reduction of transportation vehicles. The age-hardening response of conventional wrought magnesium alloys is low, but it can be enhanced by trace additions of ternary or quaternary elements. Our recent investigations have revealed that the additions of Zn and Al to Mg-Ca binary alloys cause the formation of internally ordered monolayer Guinier-Preston (G.P.) zones on basal planes, which gives rise to substantial age hardening. This is somewhat similar to the precipitation processes in Mg-RE systems with Zn addition. In this talk, we show some recent results on microalloying effects in Mg-Zn, Mg-Al-Zn, and Mg-Ca alloys based on

our recent TEM/SSTEM and 3D atom probe studies, and discuss their potential as age hardenable wrought alloys.

[KJ2-1]

Nanocrystalline Mg-Zn-Y-Al Alloys with Long Period Stacking Ordered Structure: Yoshihito Kawamura; Kumamoto University, Kuro-kami 2-39-1, Kumamoto 860-8555, Japan

Keywords: nanocrystalline, rapid solidification, LPSO, mechanical properties

A project on development of rapidly solidified powder metallurgy (RS P/M) Mg-Zn-Y alloys with long period stacking ordered structure (LPSO) has been carried out from 2003 to 2007 as the Japan national project, "Civil Aviation Fundamental Technology Program-Advanced Materials & Process Development for Next-generation Aircraft Structures", which was founded by the Ministry of Economy, Trade and Industry (METI) of Japan. RS P/M processing which is suitable for safe mass-production of nanocrystalline Mg-Zn-Y alloys was developed. Moreover, a RS P/M $Mg_{96.7}Zn_{0.85}Y_2Al_{0.45}$ alloy with both high strength and high corrosion resistance was developed. The tensile yield strength, tensile elongation and fatigue strength were 533 MPa, 8% and 325 MPa, respectively. The specific yield strength and specific fatigue strength and corrosion resistance of the nanocrystalline $Mg_{96.7}Zn_{0.85}Y_2Al_{0.45}$Å@ alloy were 1.6, 1.7 and 2.8 times as high as those of extra-super-duralumin (7075-T6). The RS P/M $Mg_{96.7}Zn_{0.85}Y_2Al_{0.45}$ alloy with LPSO structure has promising potential for use as lightweight structural material.

[KJ2-2]

Plastic Deformation Behavior of Long-period Stacking Ordered Phase Alloys: Koji Hagihara[1], Michiaki Yamasaki[2], Yoshihito Kawamura[2], Hiroyuki Y Yasuda[3]; [1]Department of Adaptive Machine Systems, Graduate School of Engineering, Osaka University, Japan. [2]Department of Materials Science, Kumamoto University, Japan. [3]Division of Materials and Manufacturing Science, Graduate School of Engineering, Osaka University, Japan

Keywords: LPSO-phase, basal slip, kink deformation, mechanical properties

Recently, Mg-alloys which contain the long-period stacking ordered phase, the so-called LPSO-phase, have been strongly focused due to their superior mechanical properties. In order to elucidate the strengthening mechanism of the Mg/LPSO two-phase alloys, we have investigated the mechanical properties and plastic deformation behavior of the LPSO-phase itself. In this presentation, the recent experimental results on the plastic deformation behavior of the LPSO-phase alloys prepared by directionally solidification (DS) and extrusion processes are shown, and their controlling mechanisms are discussed. We elucidated that two deformation mechanisms; the operation of (0001) basal slip and the formation of deformation kink, which is formed by the avalanche generation of pairs of dislocations on the basal plane, dominantly govern the plastic deformation of the LPSO-phase. Non-basal slip was also locally observed, but it is operative only under very high stress field or at high temperatures above 573 K. Due to the limitation of the operative deformation mode, the plastic behavior of the LPSO-phase exhibits strong anisotropy, and therefore the deformation behavior significantly varies depending on the microstructure and the texture of the alloys. Based on the obtained knowledge, the role of the LPSO-phase in high-strength Mg-alloy will be discussed.

[KJ2-3]

Plane Strain Compression Behavior of Magnesium Single Crystals: Ming-Zhe Bian, Kwang-Seon Shin; Magnesium Technology Innovation Center, School of Materials Science and Engineering, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-744, Korea

Keywords: Twinning, Non-basal Slip, Resolved Shear Stress, Compression Twin

Hexagonal close packed (HCP) metals have limited slip systems and thus twinning could play an important role in plastic deformation. According to the von Mises criterion, minimum of five independent deformation modes are required for a large plastic deformation. The basal slip only provides two independent modes and the slip direction is in the basal plane. Therefore, the basal slip could not allow a strain along the c-axis. Uniaxial tension and compression tests with Mg single crystals may not easily activate non-basal slip modes, because the critical resolved shear stresses (CRSS) for the prismatic, pyramidal and <c+a> slip modes are much greater than those for the basal slip and tensile twin at room temperature. However, it is possible to activate non-basal slip modes and compression twin in Mg single crystals with appropriate orientations in plane strain compression (PSC) tests. It is possible to suppress the basal slip and the {10-12} tensile twin and activate non-basal slip modes. In this study, deformation by non-basal slip and twinning was systematically investigated in Mg single crystals.

[KJ3-1]

Twinning Behavior of Mg Alloy-Effect of Stress Axis, Twin Interface Introduced by Pre-straining, Texture and Alloying Element: Seiji Miura; Hokkaido University, Sapporo 060-8628, Japan

Keywords: single crystals, strain compatibility, EBSD analysis, grain boundary, Schmid's law

Twinning behaviors of Mg alloy single- and poly-crystals are investigated. In Mg-Zn alloy single crystals it was confirmed that both the work-hardening rate and the number of serration in the stress strain curve depends on the stress axis ([10-10] or [11-20]) because of the number of operative twin systems. In order to understand the effect of grain boundaries on the twinning in Mg alloys, twin boundaries are introduced to single crystal specimens as pseudo grain boundaries by pre-straining of about 2% plastic strain. Using EBSD analysis, the importance of the strain compatibility at grain boundaries for introducing twins is confirmed by

examining the microstructure evolution around the pseudo grain boundaries. Also the progress of twinning in AZ31B alloy sheet with a texture was investigated by in-situ bending test conducted under a confocal scanning laser microscope. With increasing the deformation strain, the total area of twins increases. However, it is noted that the widening of twins is apparent while the number of twins is almost constant during plastic bending deformation. EBSD analysis suggested that twinning behavior obey Schmid's law even in the poly-crystal.

[KJ3-2]

Texture Evolution of Mg Alloys: Hyo-Tae Jeong and Byung-Hak Choe; Dept. of Advanced Metal and Materials Engineering, Gangneung-Wonju National University, Gangneung 210-702, Korea

Keywords: magnesium alloys, texture, asymmetric fabrication

The limited formability of magnesium alloys at room temperature originated from the following two facts. One is the limited number of active slip systems in the hexagonal close packed crystal structure and the other is the geometrical configuration of the limited slip systems determined by the texture of magnesium alloys. Recently, it was shown that magnesium alloys could be exceptionally ductile at room temperature through texture control using equal-channel angular pressing (ECAP), whereby a tilted basal texture with c-axes inclining toward extrusion direction by about 40 degrees was obtained. However, the ECAP process is inadequate to fabricate wide Mg sheets. Therefore, many new fabrication processes have been studied to change the basal texture of magnesium alloys for improving the room temperature formability. These processes have tried to improve the tensile ductility by tilting basal texture toward the rolling direction and/or by weakening the basal texture. In this study, the texture evolutions during newly developed fabrication processes have been discussed.

[KJ3-3]

Twin-Roll Casting of Mg Alloys-Opportunities and Challenges: J.H. Bae, D.W. Kim, B.C. Suh, M.-S. Shim, N.J. Kim; CAAM & GIFT, POSTECH.

[KJ3-4]

Microstructure and Mechanical Properties of Twin Roll Cast and Differential Speed Rolled Magnesium Alloy Sheet: S.B. Kang, J.H. Cho, L.L. Chang; Korea Institute of Materials Science (KIMS), Changwon 641-831, Korea

Keywords: magnesium alloy sheet, twin roll cast, differential speed rolling, microstructure, mechanical properties

Twin-roll casting (TRC) process combines casting and hot rolling into a single step, having an advantage of one-step processing of flat rolled products. Besides being such a cost-effective process, TRC also has a beneficial effect on microstructure such as reducing segregation, improving inclusion size distribution, refining microstructural and textural homogeneity. However, conventional equal speed rolling (ESR) of TRC magnesium alloy strip preserves a strong basal texture as often found in the rolling of conventional cast ingot (IC). The ductility of magnesium alloys is strongly affected by the texture. Thus, it is important to control the texture during processing for improvement of ductility at room temperature during sequential processing. Recently it has been reported that differential speed rolling (DSR) is effective for improving tensile elongation and formability of magnesium alloys by reducing the intensity of basal texture. Thus, it is of great interest to combine TRC and DSR technique for more efficient production of magnesium alloy sheet with improved ductility. The present paper reports the comparison of microstructure and mechanical properties of AM31 alloy fabricated by TRC/IC followed by DSR/ESR.

[KJ3-5]

Quality Development of Mg Alloy Sheet Production in POSCO: Oh-Duck Kwon[1], Jong-Duck Park[1], Woo-Jin Park[2], D. Choo[2], Sang-Ho Cho[1]; [1]Magnesium business department of POSCO. [2]Magnesium flat product research project of RIST

Keywords: magnesium sheet, strip casting, warm rolling, crack

POSCO started its commercial production with strip casting and warm rolling mill, 2007. To ensure high quality and customer satisfaction, casting and rolling technologies were developed for 600 mm wide caster. Strip casting condition was optimized to ensure the surface quality, such as inverse segregation and edge crack. Warm rolling technology was developed with online heater after soaking cast strip in furnace. As the result, surface crack was removed and edge crack was minimized in the rolled sheet. Based on technology development, the application area of magnesium sheet can be widen.

[KJ3-6]

Improving Mechanical Properties of Mg Alloys Using High-ratio Differential Speed Rolling: W. J. Kim; Dept. of Materials Science and Engineering, Hongik University, 72-1 Mapo-gu, Sangsu-dong, Seoul 121-791, Korea

Grain refinement in magnesium alloys by thermo-mechanical processing has been widely studied in the recent past to enhance their mechanical properties. Conventional processes such as extrusion and rolling produced the grain sizes between 3 and 20 ìm. To get finer microstructures, severe plastic deformation (SPD) techniques have been used and equal channel angular pressing is the representative SPD process. It has been demonstrated by our group that high-ratio differential speed rolling (HRDSR) is quite effective in achieving very fine grained microstructure in many magnesium alloys by inducing high shear straining during the rolling process for a large thickness reduction through a single rolling pass. Recently, our group proposed a novel method of fabricating the ultrafine-grained (UFG) AZ31 sheets with mean grain sizes of 0.5~1 μm by applying HRDSR under the condition that a cold sheet was severely deformed in hot

rolls. Proper control of the working parameters such as roll speed, roll-speed ratio and roll temperature was critical in maximizing the grain-refining efficiency and optimizing the texture. A novel method of fabricating age-hardenable magnesium alloys with high strength and high ductility was also developed using the HRDSR technique. For example, the UFG Mg–9Al–1Zn alloy after low-temperature aging exhibited a high yield stress of >400 MPa. The HRDSR technique can be also used in production of superplastic Mg alloys. In 2010, a method for fabricating high-strain-rate superplastic Mg alloys by using HRDSR was proposed. The ingot-metallurgy processed Mg alloy exhibited a superplastic performance comparable to that of powder-metallurgy (PM) counterparts. By optimizing the controlling parameters in the rolling process, an ultrafine-grained microstructure with good thermal stability, which is the desired microstructure for achieving high-strain-rate superplasticity, could be obtained. The present technique has great advantages over PM and other SPD processing methods from the viewpoint of productivity and economy. This is because the high strain rate superplastic sheets can be fabricated with significantly reduced manufacturing steps and costs. Heavy pre-deformation and sheet preheating prior to rolling are not required, and a single rolling pass is often sufficient to achieve the desired microstructure.

[KJ4-1]

Development of High Strength Mg-Al-Ca-Mn Alloy by Extrusion: Shigeharu Kamado, Tomoyuki Honma and Shiwei Xu; Nagaoka University of Technology, Nagaoka 940-2188, Japan

Keywords: Mg-Al-Ca alloy, Precipitation, Dynamic Recrystallization, Extrusion, Mechanical properties

From the view point of improvement of fuel consumption, Mg alloys with the lowest specific gravity attract as structural materials for the applications to transportation vehicles. However, applications of extruded Mg alloys to structural components are still limited due to the fact that strengths of conventional Mg alloys such as AZ31 alloy are generally insufficient compared with those of steels and Al alloys. In addition, the compressive proof strengths (CPS) of conventional extruded Mg alloys are remarkably smaller than the tensile proof strengths (TPS). A combination of grain refining and fine precipitates through thermomechanical treatment is very effective for the improvement of mechanical properties including the ratio of CPS to TPS representing the yielding anisotropy in the wrought Mg alloys. Recently, Jayaraj et al.[1] reported that a trace addition of Al to Mg-Ca alloy leads to precipitation of ordered GP zone parallel to the basal plane, resulting in remarkable age hardening. However, relationships between microstructures and mechanical properties in the extruded Mg-Al-Ca systems have not been clarified yet. In this study, effects of as-cast microstructures and heat treatment on microstructures and mechanical properties of the extruded Mg-Al-Ca based alloys have been investigated in order to improve mechanical properties of wrought magnesium alloys by utilizing dynamic phenomena such as dynamic recrystallization assisted by second phases, for example, crystallized compounds and dynamically-precipitated phases.

1) J. Jayaraj, C.L. Mendis, T. Ohkubo, K. Oh-ishi and K. Hono: Scripta Mater., 63 (2010), 831-834.

[KJ4-2]

Indirect Extrudsion of High Strength Mg Alloys: Bong-Sun You, Sung-Soo Park; Korea Institute of Materials Science (KIMS), Changwon 641-831, Korea

Keywords: wrought magnesium alloys, extrusion, microstructure, mechanical properties

Mg alloys are usually extruded at speeds that are 5~10 times slower than those attainable by Al alloys. The extrusion speed may become faster at higher temperature in the light of extrusion pressure, but the maximum temperature allowable is usually restricted by hot cracking which occurs when temperature during extrusion reaches the solidus temperature of α-Mg or the incipient melting temperature of 2nd phase particles. Nonetheless, overcoming the issue by developing high strength wrought Mg alloys with good extrudability is very critical to expand the application fields of extruded Mg alloy products. Therefore, the present study aims at developing high strength Mg alloys extrudable at high speed (higher than 10 m/min) without hot cracking. Effects of alloying elements and extrusion conditions on the microstructure and mechanical properties of extruded alloys will also be discussed.

[KJ4-3]

Grain Refinemet of Mg-Al-Zn Alloy by Repetitive Oblique Shear Strain: Toshiji Mukai, Hidetoshi Somekawa, Alok Singh, Tadanobu Inoue; National Institute for Materials Science (NIMS), Tsukuba, Ibaraki 305-0047, Japan

Keywords: caliber rolling, shear strain, grain refinement, texture, mechanical properties

Enhancing fracture toughness and/or ductility is requirement for reliability in structural application. It has been reported that the grain refinement is one of the possible ways to enhance the strength without losing the ductility. In this study, oblique shear strain by caliber rolling has been demonstrated to refine the grain structure of a commercial AZ31 Mg-Al-Zn alloy effectively at a commercial processing speed with the formation of fine sub-grains in a sub-micrometer scale and resulted in a high yield stress of more than 400 MPa. A simultaneous operation of oblique shear strain weakened the basal texture compared to that of the initial as-extruded alloy, and resulted in tensile ductility comparable to that of the commercially extruded alloy, and showed a higher asymmetry ratio of yield stress in compression/tension than that of the as-extruded alloy.

[KJ4-4]

Effets of Zn Concentration on the Room Temperature

Formability of Rolled Mg-Zn-Ce Alloys: Yasumasa Chino[1], Mamoru Mabuchi[2]; [1]National Institute of Advanced Industrial Science and Technology, Nagoya 463-8560, Japan. [2]Kyoto University, Kyoto 606-8501, Japan
Keywords: magnesium alloys, rolling, formability, texture, mechanical properties

The dilute addition of special elements such as Ce, Y, Gd, La and Ca in Mg-Zn alloy is an effective method for improving room temperature formability of rolled Mg alloys. In this presentation, the authors report the relationships between Zn concentration and room temperature formability of the rolled Mg-Zn-Ce alloys. The dilute Zn addition more than 0.5 wt% effectively modified the basal plane texture, which was characterized by the splitting basal pole toward the TD. However, further Zn addition did not have a strong influence on the distribution and intensity of the basal plane texture. The Mg-1.5wt%Zn-0.2wt%Ce alloy showed significant stretch formability. On the other hand, further Zn addition deteriorated the stretch formability of Mg-Zn-Ce alloys, although it did not affect the distribution and intensity of the basal plane texture. The deterioration of the stretch formability of Mg-Zn-Ce alloys with high Zn concentration was suggested to be responsible for the solid solution hardening. Besides, it was suggested that not only the texture but also the solid solution softening likely played an important role in the enhanced stretch formability of the Mg-Zn-Ce alloys.

[KJ4-5]
Stud Welding of SC & Rolled Mg Sheet for it Device Case: Mok-Young Lee; Research Institute of Industrial Science & Technology (RIST), Pohang 790-330, Korea
Keywords: wrought magnesium alloys, stud welding, micro-structure, mechanical properties

Magnesium sheet were used in electrical device case due to its mobility and EMF shielding characteristics. Magnesium case by press forming was advantageous compare with conventional die casting process, because of its thin gauge of wall and surface quality. But it needs to makes the boss to fix inner part or assemble the case. CD stud welding was effective way for joining the boss to the thin gauge case of the electrical devices. In this study, we investigated the performances of the stud welder using strip cast and rolled magnesium sheet. To measure the process parameters such as the force and the weld current, we design the monitoring system for CD stud welding. We test the characteristics of CD stud welding for AZ31 sheets at some variables. Finally we select the optimum welding range of magnesium sheets in CD stud welding process. The tensile strength was over than 50 kgf at 50V charging voltage.

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