Mechanical Properties & Material Processing of Magnesium-Lithium Alloys

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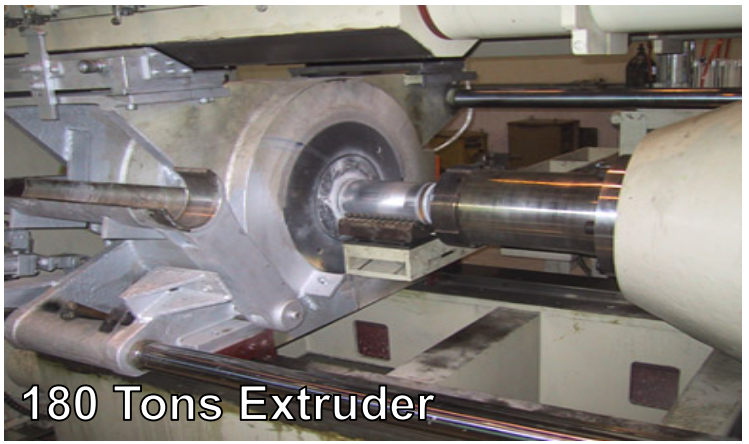
AmLi Materials Technology Co. LTD. Taiwan

---Specialized Manufacturing Company of Magnesium Alloys

---Alloy Design, Melting & Casting, Extrusion & Rolling, Deep Drawing & Pressing, Heat Treatment, Surface Treatment, Product & Application


VIM System


180 Tons Extruder


Rolling Equipment


Heat Treatment Furnace

Partnership of AmLi for Research and Development

--Chung-Shan Institute of Science & Technology

--National Taiwan University / National Dong-Hwa University*

--Huang-Chieh Metal Industry Co., Ltd.**

--Fuji Light-Metal Company Ltd./ Nippon Kinzoku***

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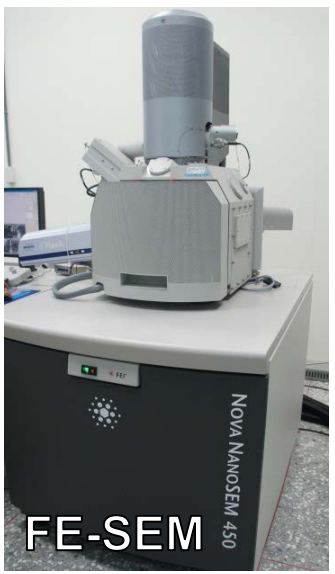
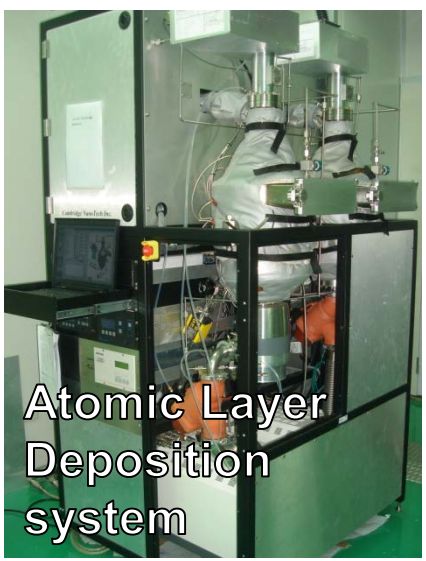
Collaboration Topics

Alloy Design *Material Processing*

Material Analysis *End-User Applications*





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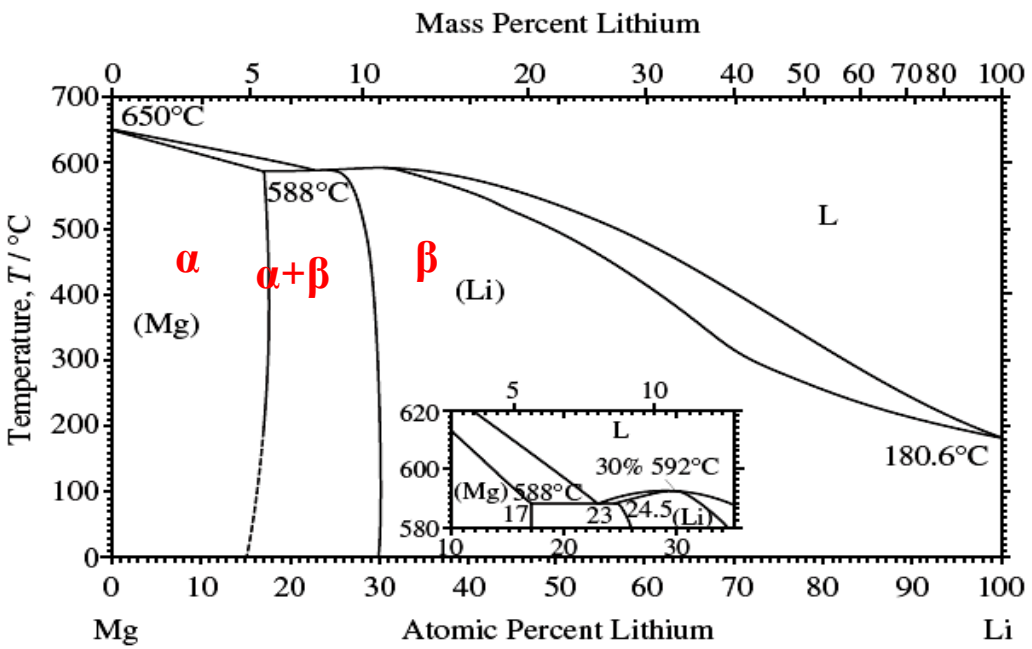
Introduction

- **Magnesium alloys are considered as potential candidates for numerous applications, especially in transportation vehicles or lightweight sectors for 3C (computer, communication and consumer electronic) products owing to the excellent properties, such as low density, high specific strength, high damping capacity and high recycle ability.**

Mg-Li alloys

- **The Magnesium-Lithium (Mg-Li) alloys with Li contents ranging from 5 to 11 mass% exhibit a dual-phase structure of Mg-rich (α-hcp) and Li-rich (β-bcc) phases. This dual-phase structure has excellent formability and extra-low density, but exhibits a moderate mechanical strength and a poor corrosion resistance.**



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- **In this presentation, a variety of Mg-Li alloys (LZ51-LZ121) are prepared. Their densities are measured and compared to other light metals. The relationships between the chemical compositions, microstructures and mechanical properties for these Mg-Li alloys are presented. Meanwhile, the improvement of their mechanical properties and corrosion resistance are also demonstrated.**

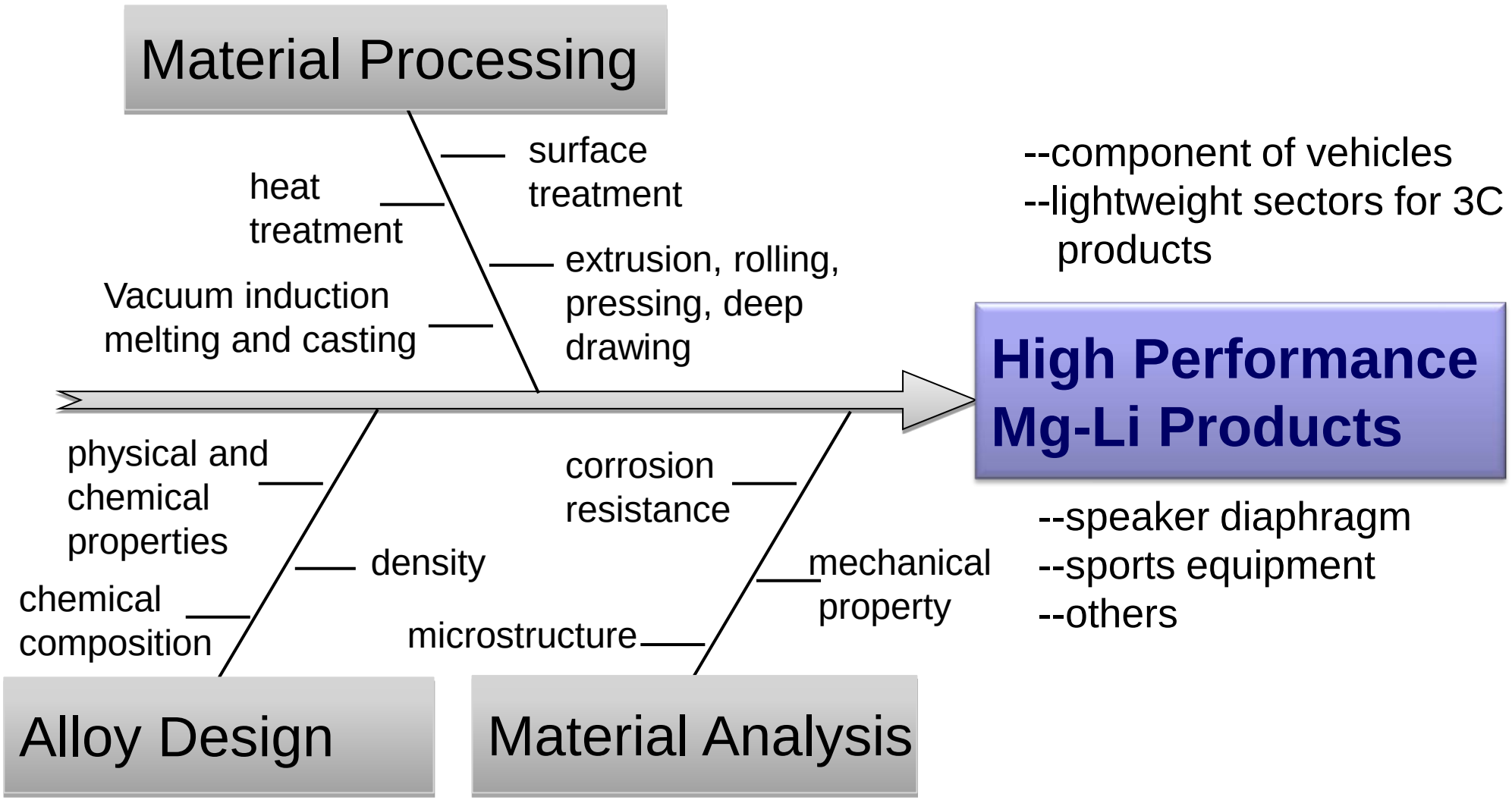
Alloy	Mg	Li	**LZ51--LZ121**	AZ80	Al	Ti
Density (g/cm^3)	1.74	0.53	**1.60--1.43**	1.80	2.7	4.5

Chemical compositions:

Li: 5~12 wt%
Zn:1 wt%
Mg: balanced

Mg-Li alloys are the lightest structure metals for engineering applications.

Manufacturing Process of Mg-Li alloys



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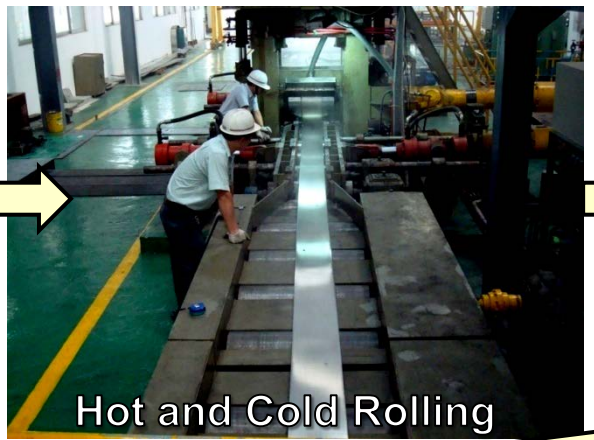
Manufacturing Process of Mg-Li alloys

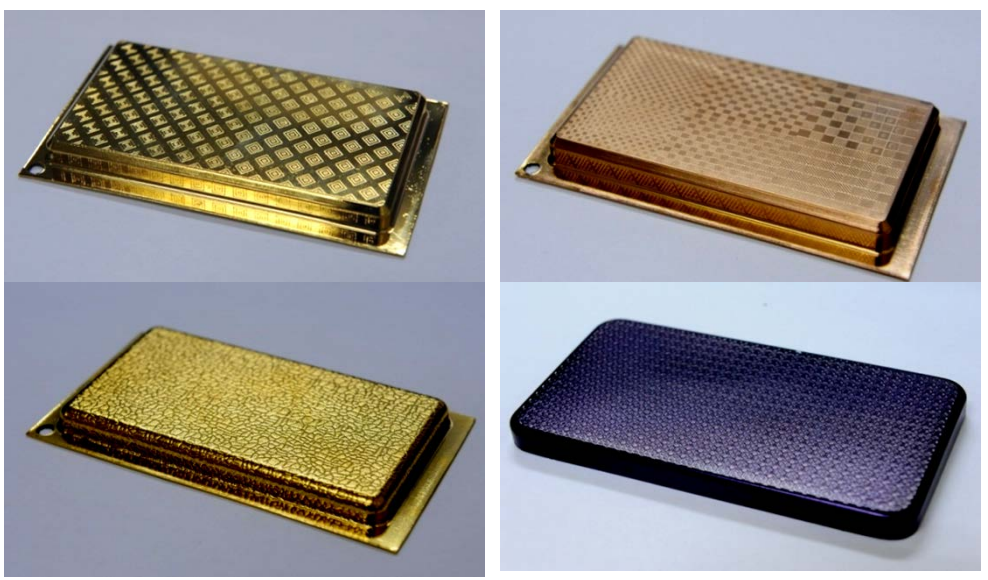

Plates of Magnesium Alloys


Hot and Cold Rolling


Sheets of Magnesium Alloys


NB cover made by super-plasticity


NB cover made by pressing


Mobile phone cover made by super-plasticity

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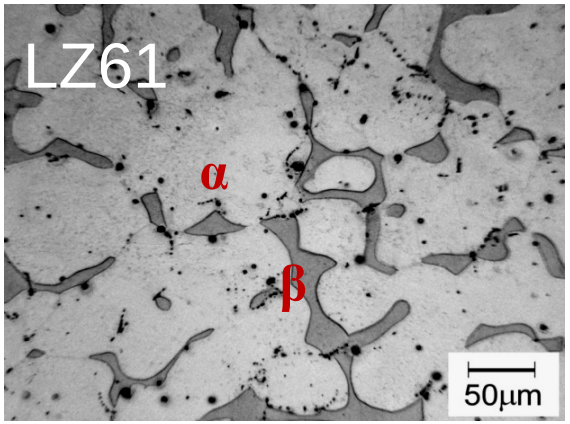
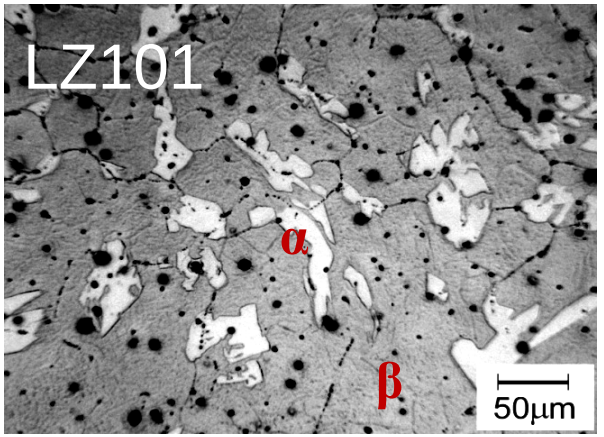
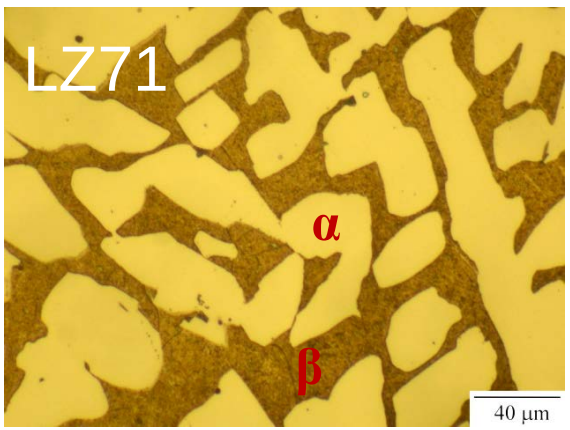
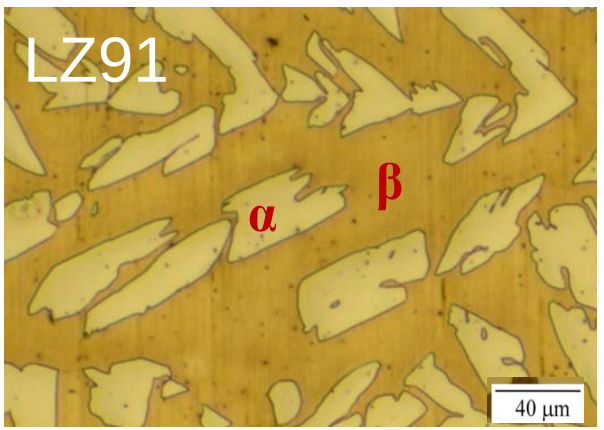
- *Microstructures of Casted Mg-Li alloys*









Alloy	LZ51	LZ61	LZ71	LZ81	LZ91	LZ101	LZ121
α / β	**97/3**	**82/18**	**64/36**	**46/54**	**32/68**	**16/84**	**0/100**

*** The LZ51 alloy has a nearlyα phase, and the LZ121 exhibits a singleβphase. With increasing Li content, moreβphase are formed.**

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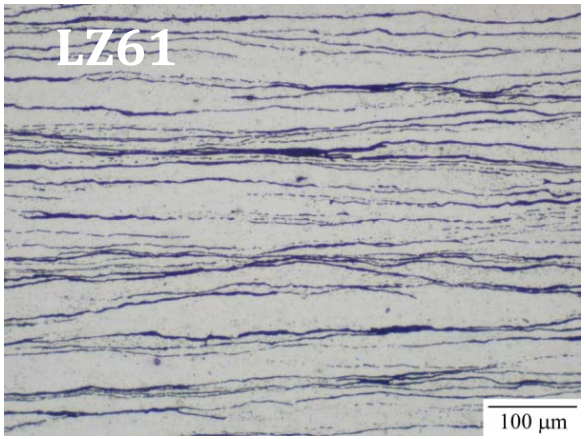
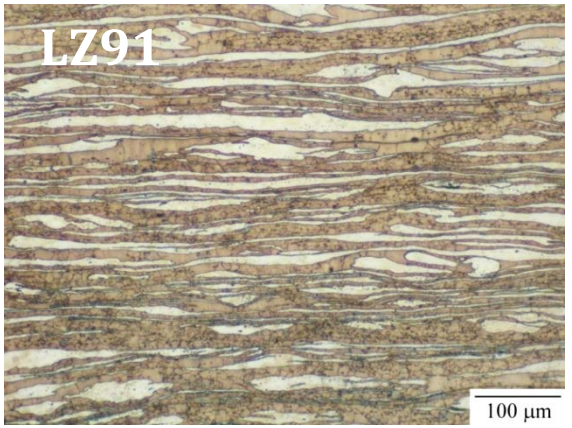
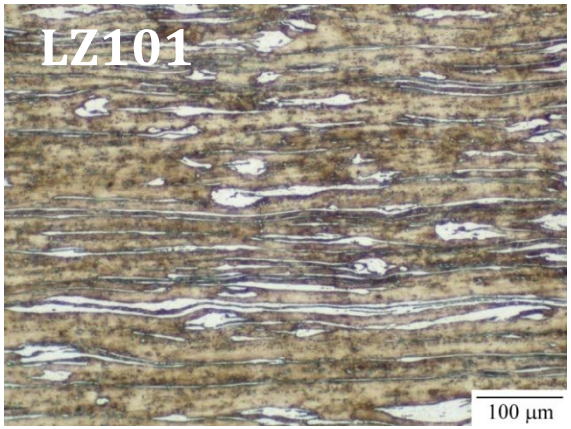
- *Microstructures of Annealed Mg-Li alloys*

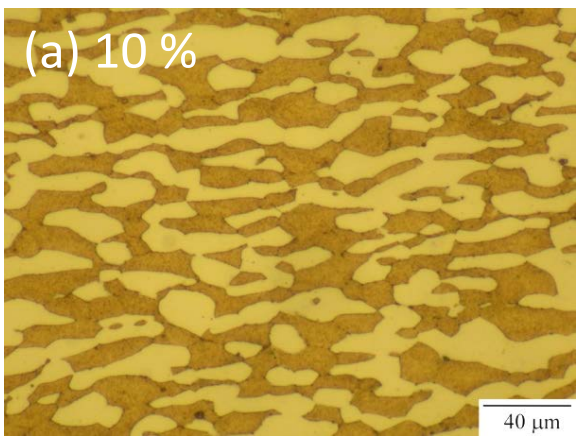


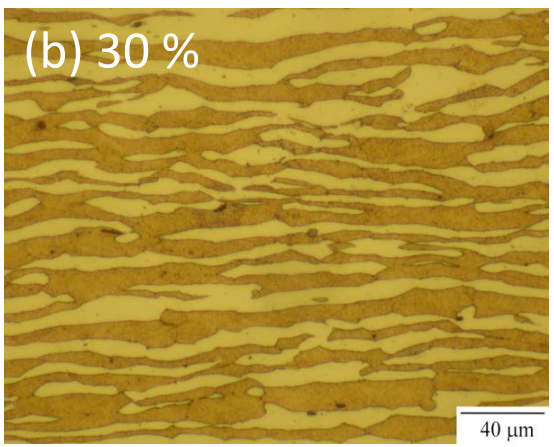


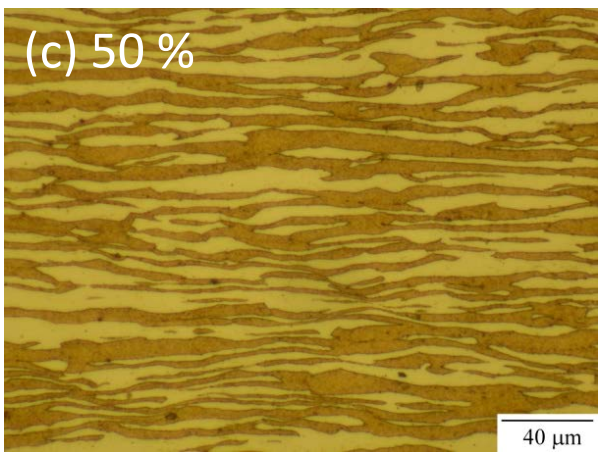


*** Both α and β phases are elongated after rolling process.**

- *Effects of cold-rolling on the microstructures of LZ91 alloy*







*** After a severe cold rolling, the fine elongated α/β phases are formed.**

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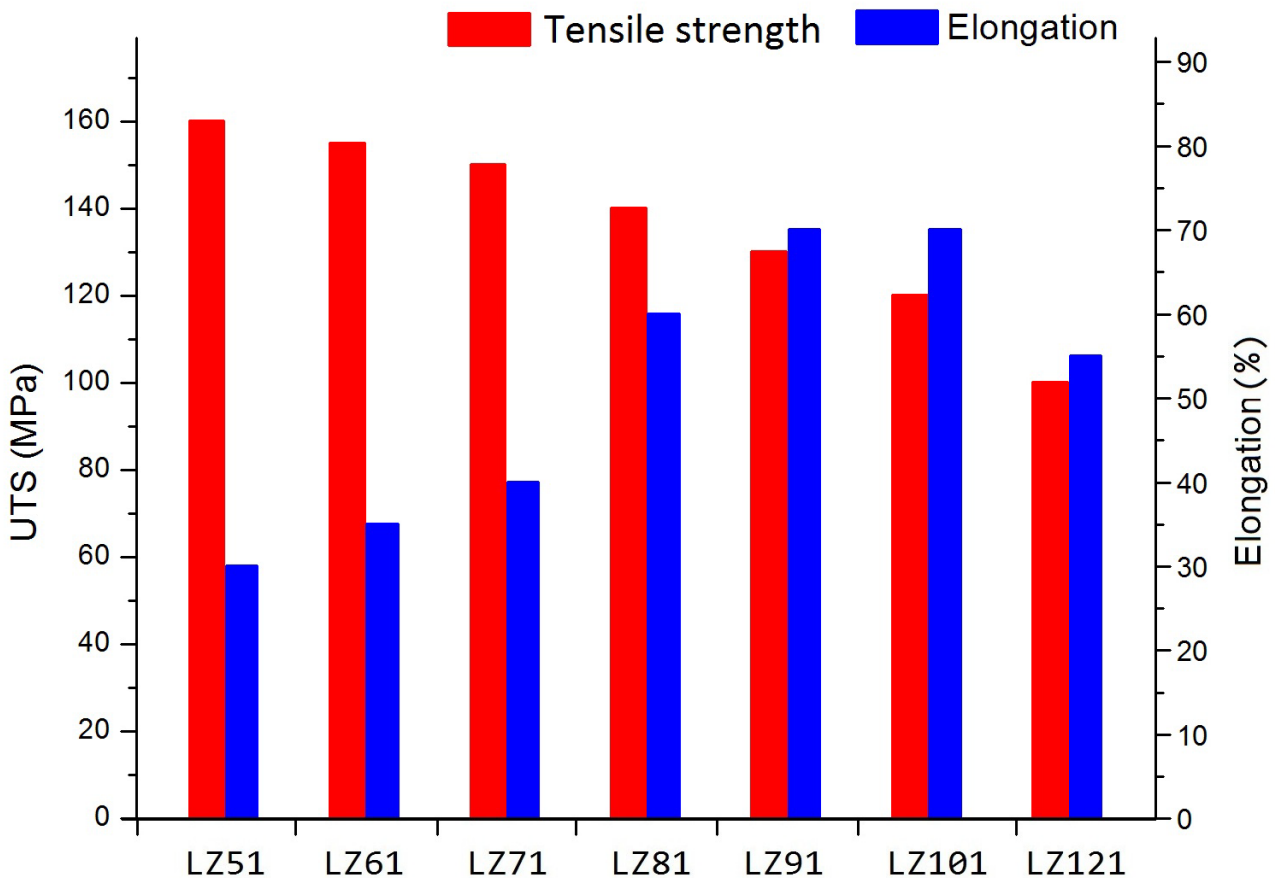
- *Mechanical properties of Annealed Mg-Li alloys*



*** The Mg-Li alloy with a high Li content has a low tensile strength and a high elongation.**

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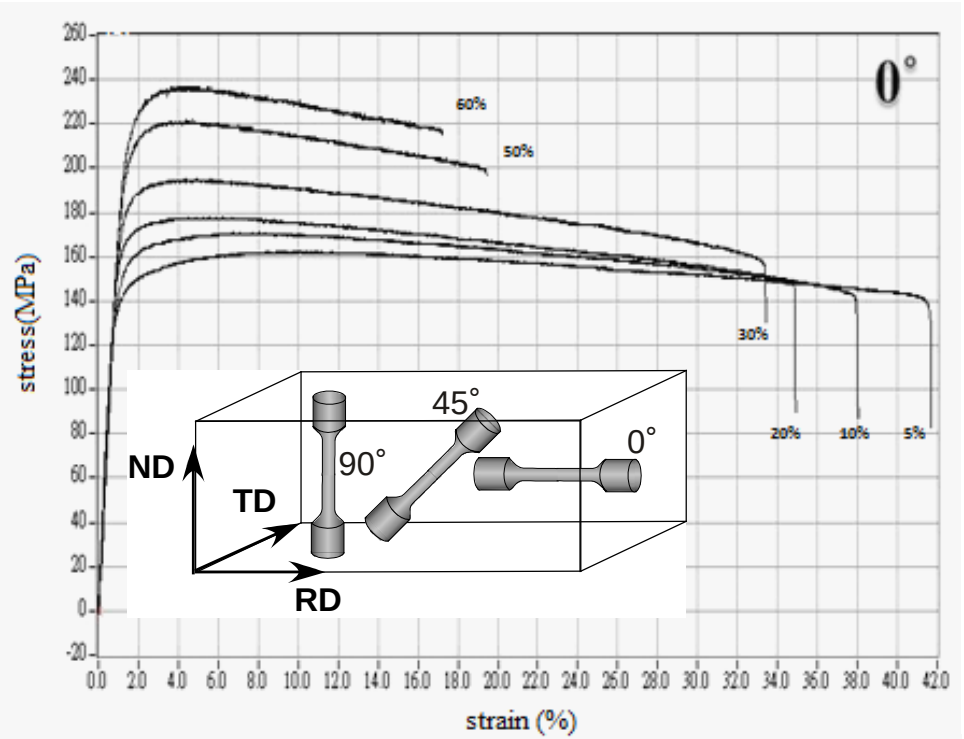
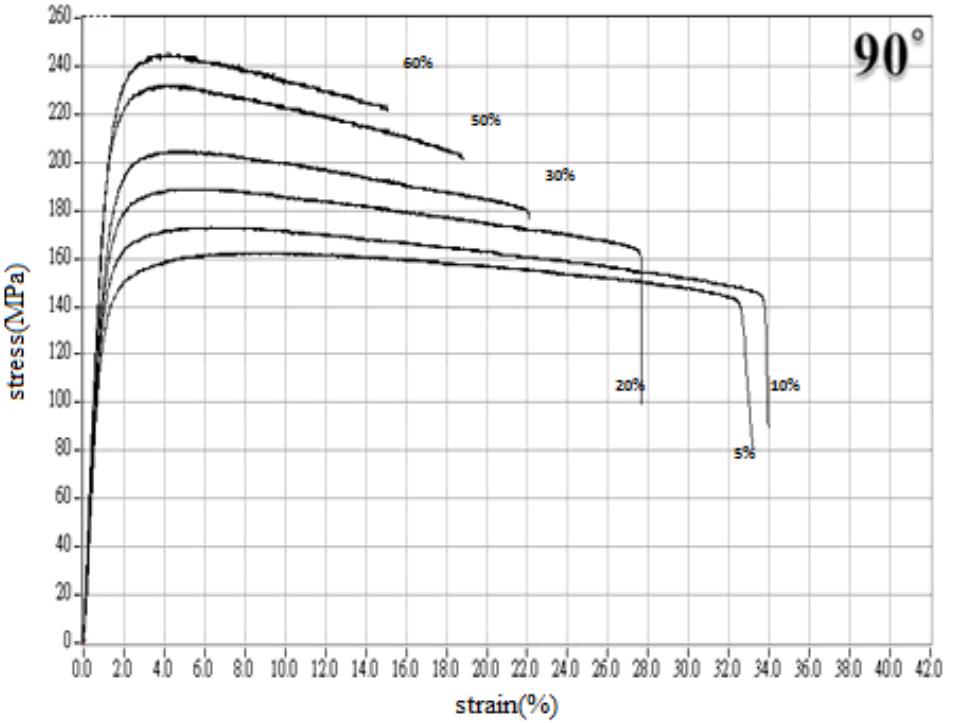
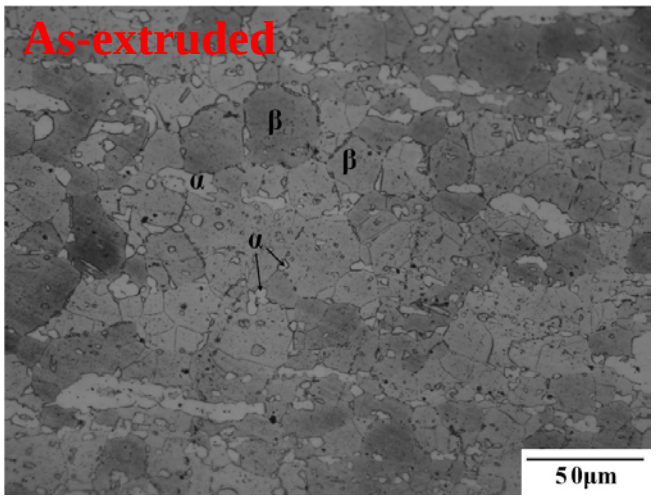
- *Effects of cold-rolling on the mechanical properties of LZ101 alloy*

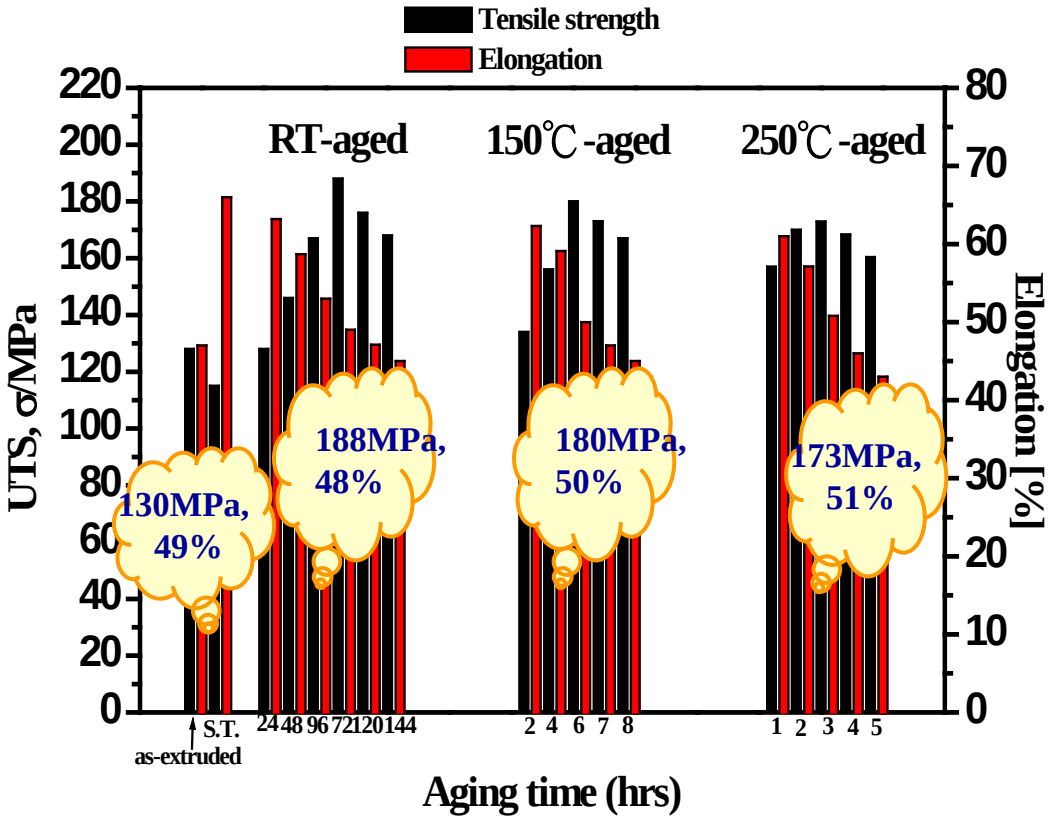


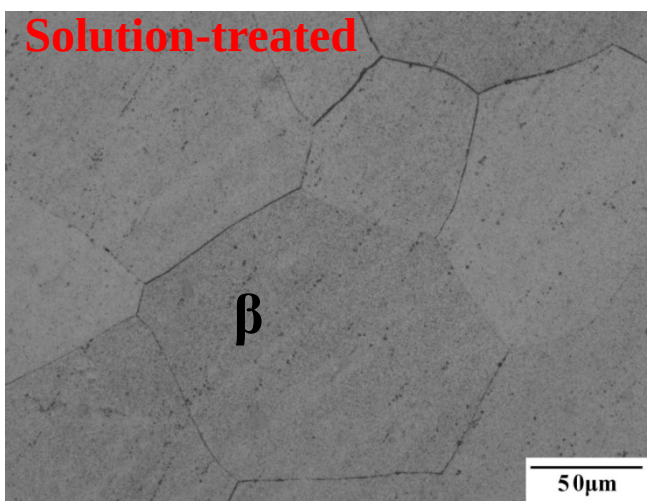


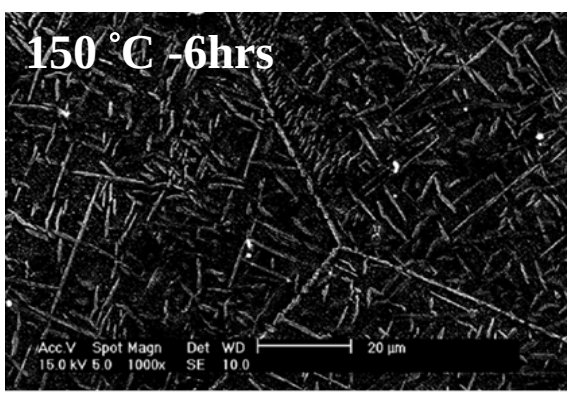
*** The tensile strength increases, but fracture strain (elongation) decreases, with increasing amount of cold rolling.**

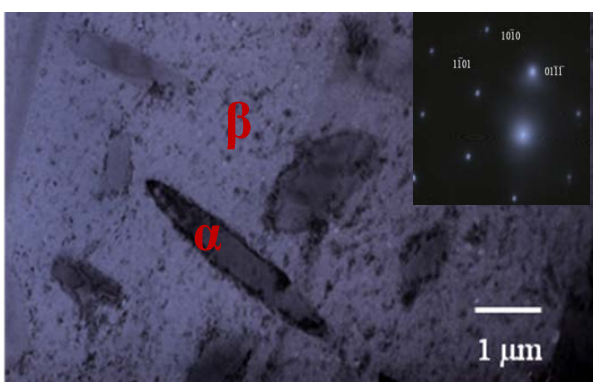
Effects of aging precipitates on the mechanical properties of LZ101 alloy











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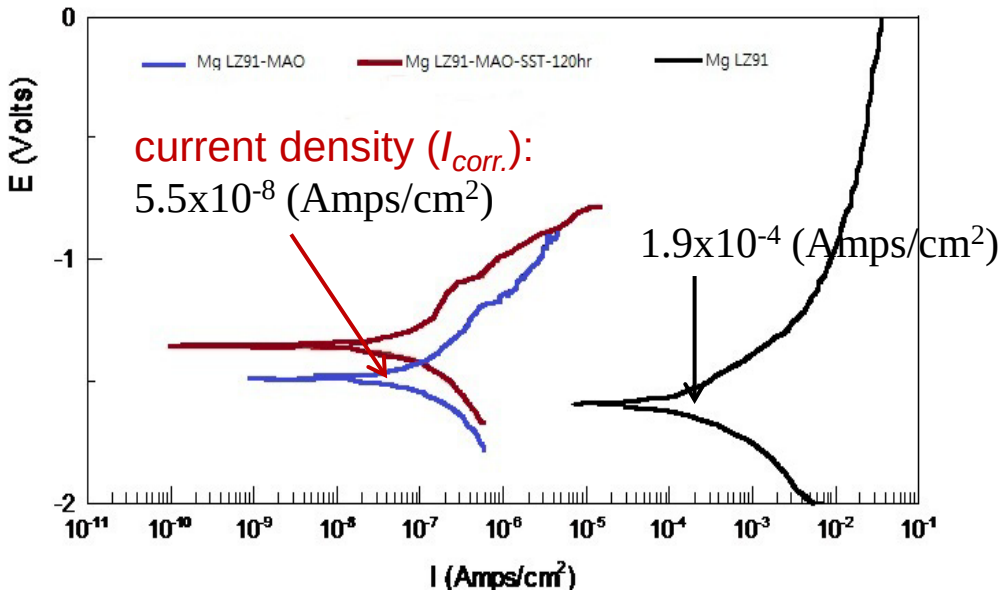
• *Corrosion Resistance--MAO (micro-arc oxidation)*

White color

LZ91

Potentio-dynamic polarization curves



Silver color

LZ91

Salt-spray test – 120 h

Great !

LZ91

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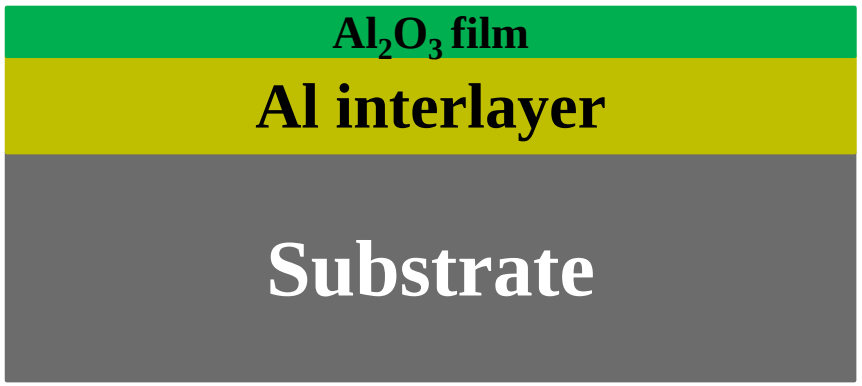
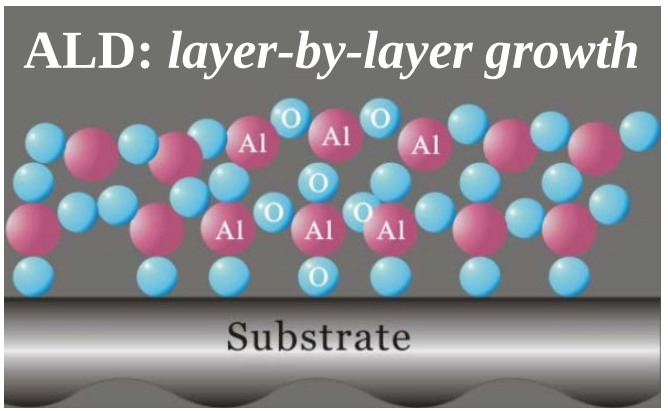
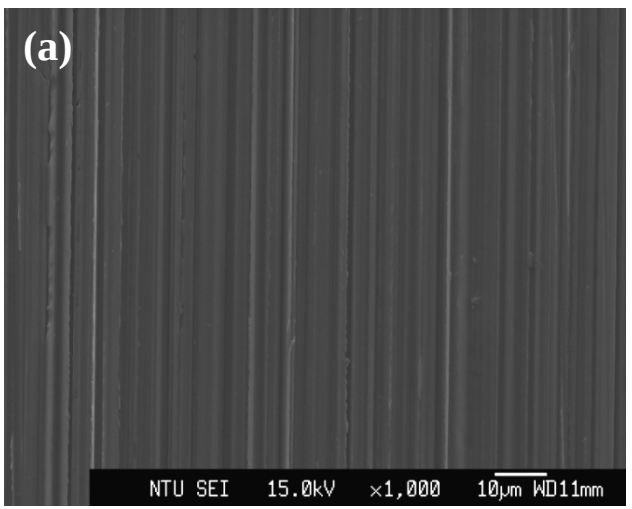
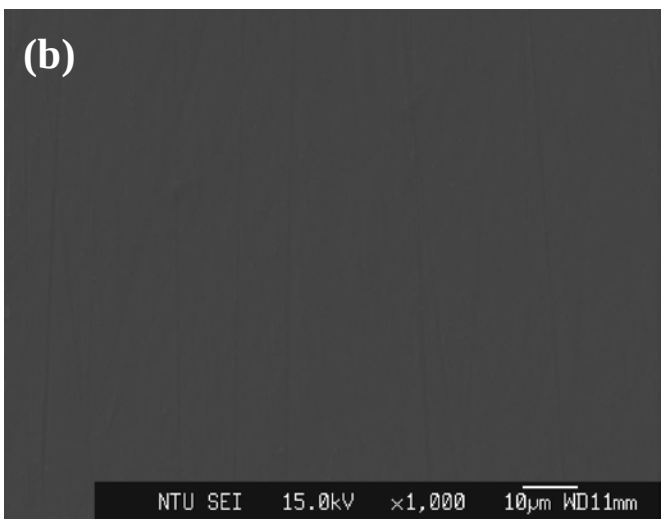
- *Corrosion Resistance--sputter and Atomic Layer Deposition (ALD)*









Surface morphologies of the LZ101 specimens. (a) the bare specimen, (b) the specimen with deposition of a dual-layer Al/Al_2O_3 film.

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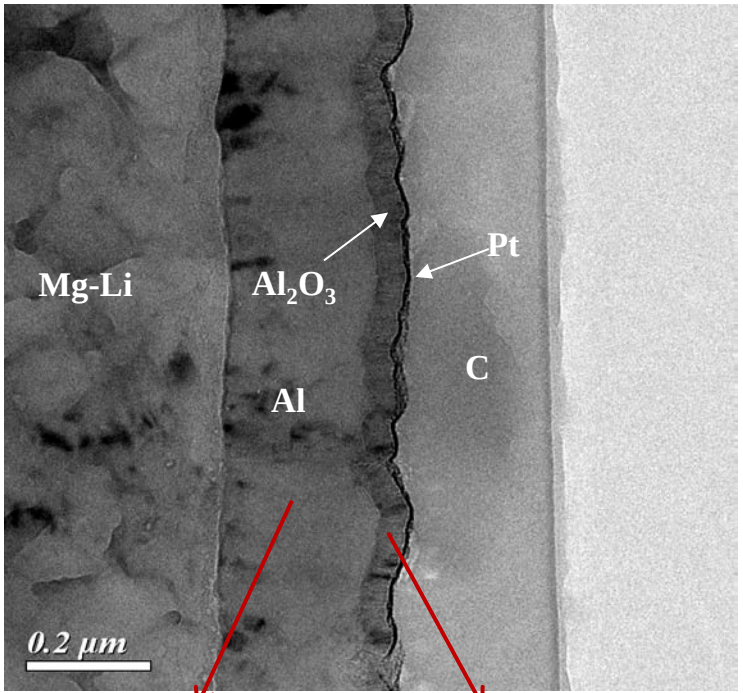
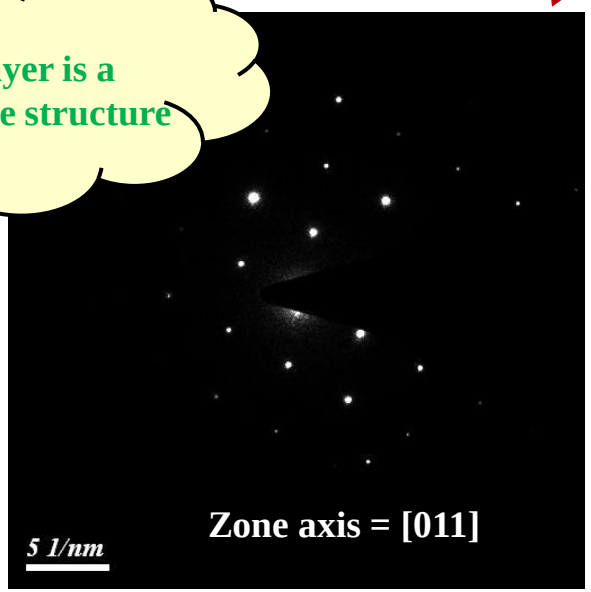
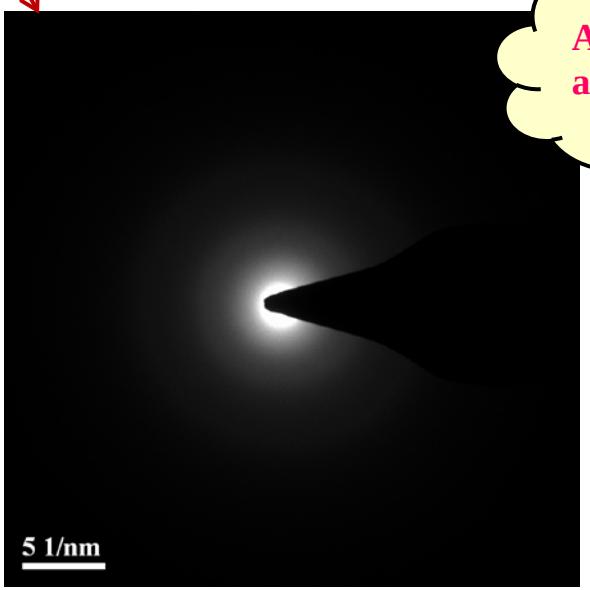
TEM analysis



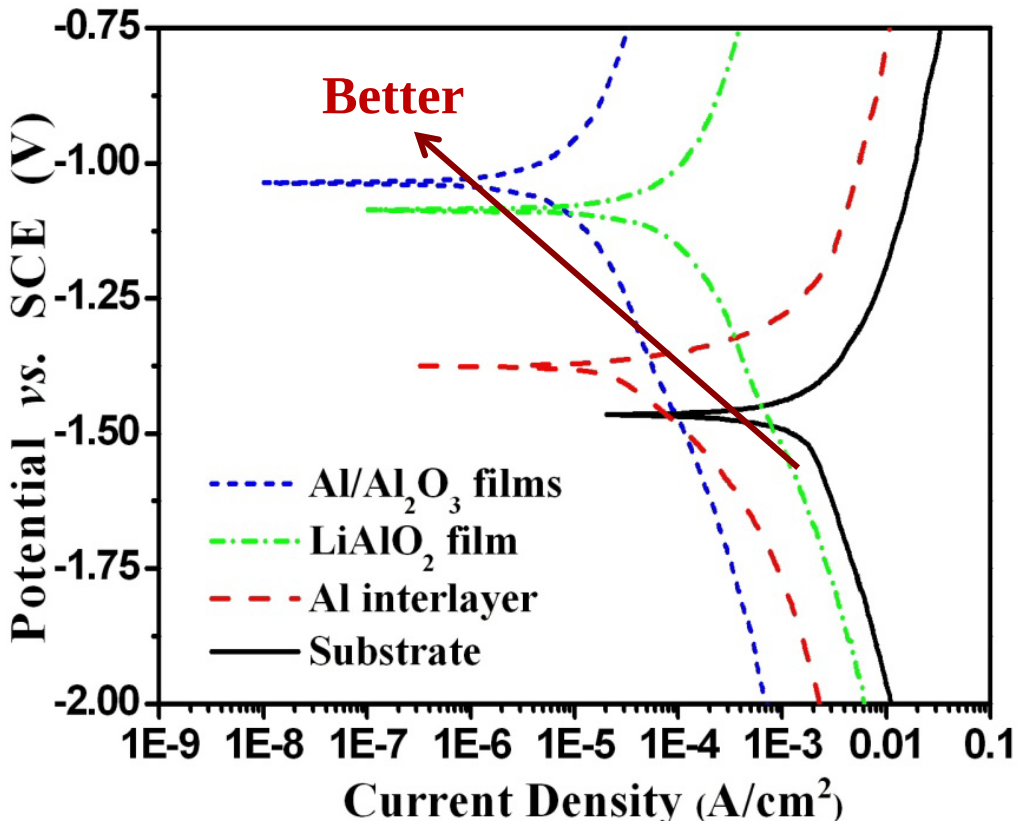
Al interlayer is a crystalline structure





ALD-Al_2O_3 film is amorphous

Potentio-dynamic polarization curves



Higher potential ($E_{corr.}$) and lower current density ($I_{corr.}$) indicate a better corrosion resistance for Mg-Li alloys with deposition of a dual-layer Al/Al_2O_3 film.

Summary

1. AmLi, focusing on light metal developments (density: 1.4~1.8 g/cm^3), has developed a series of Mg-Li alloys with designed chemical compositions, densities, microstructures and mechanical properties.
2. The mechanical properties of Mg-Li alloys can be improved by thermal-mechanical treatments, such as fine-grain strengthening, precipitation hardening, etc.
3. MAO and sputtering/ALD techniques can improve significantly the corrosion resistance of Mg-Li alloys.
4. Mg-Li alloys having excellent mechanical properties and manufacturability, can be considered as potential candidates for numerous applications, especially in transportation vehicles or lightweight sectors for 3C products.