Development of Magnesium Powder Metallurgy Alloys

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Outline

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- Methodology
- Experimental Procedure
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- Acknowledgments

Introduction

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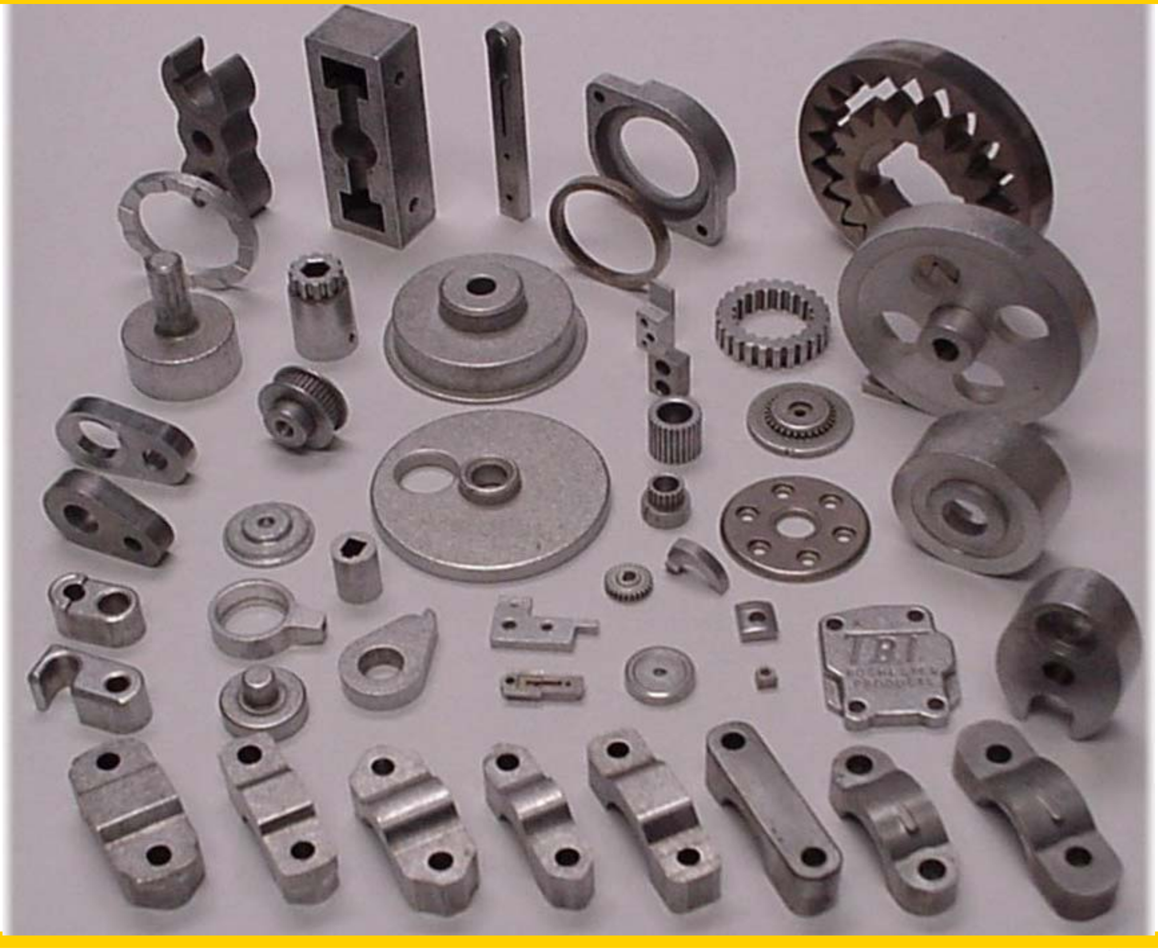
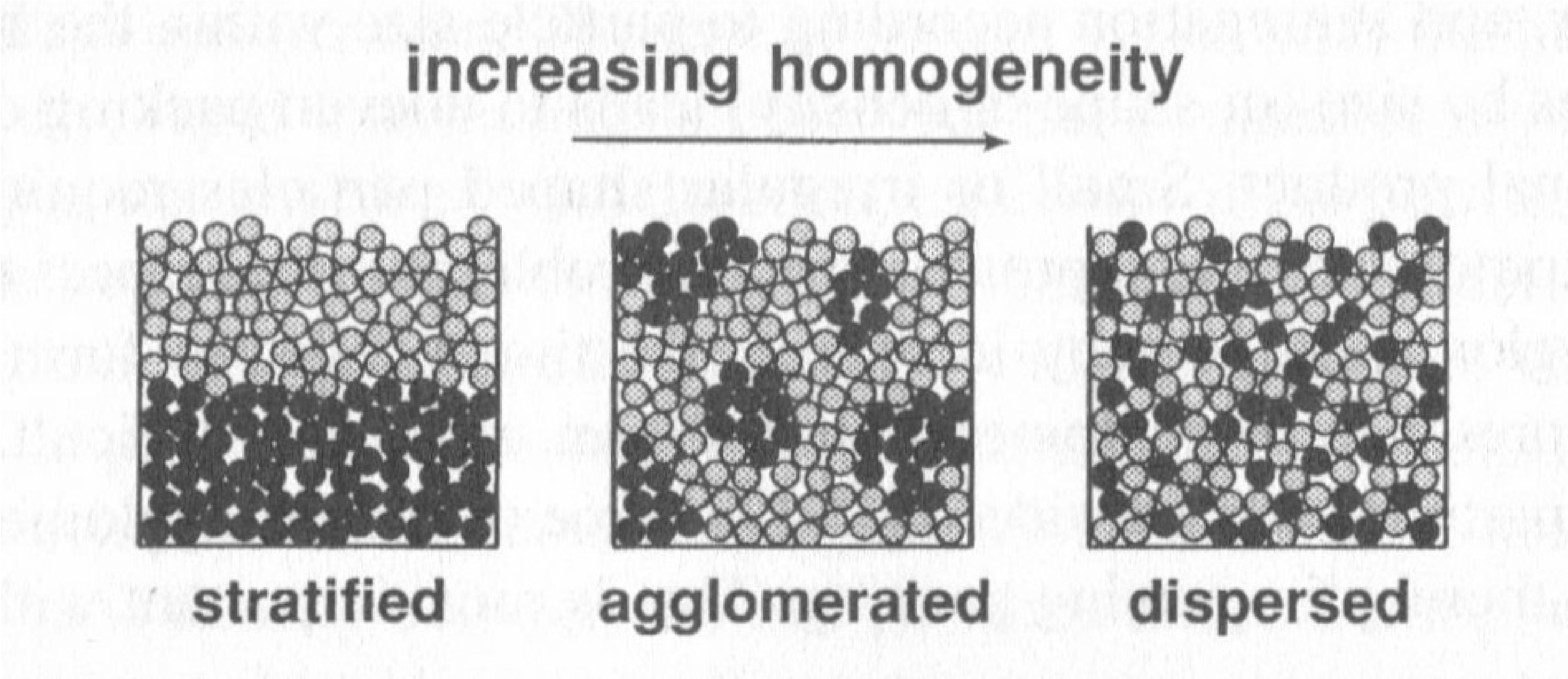


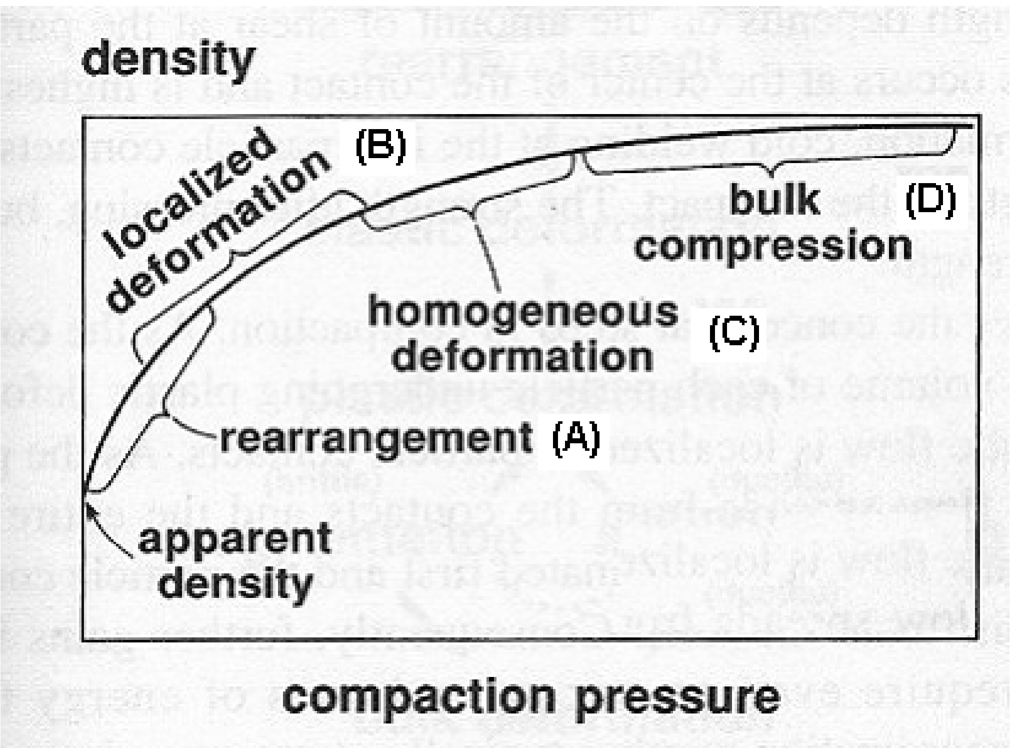
Powder Metallurgy

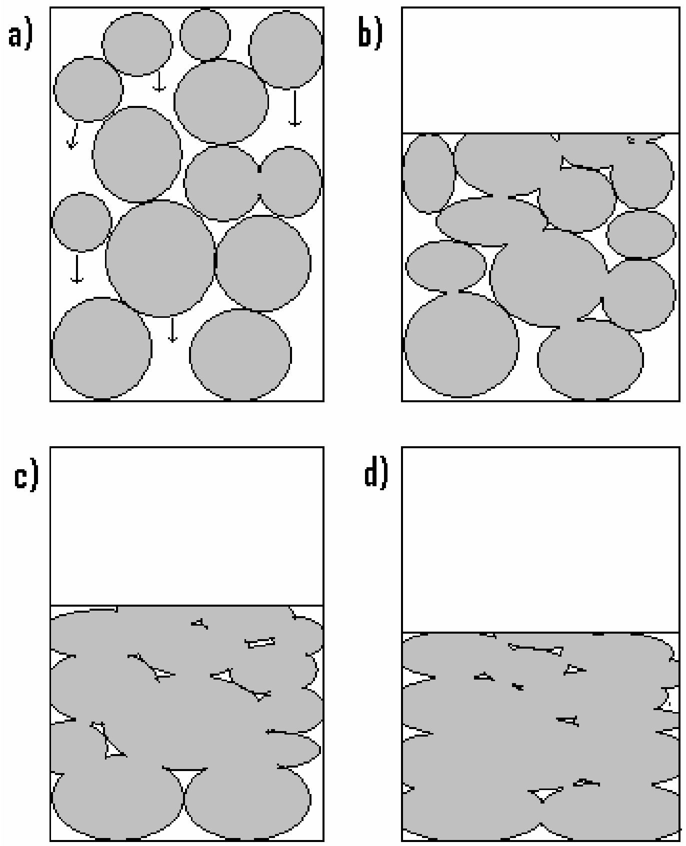
- Blending



Powder Metallurgy

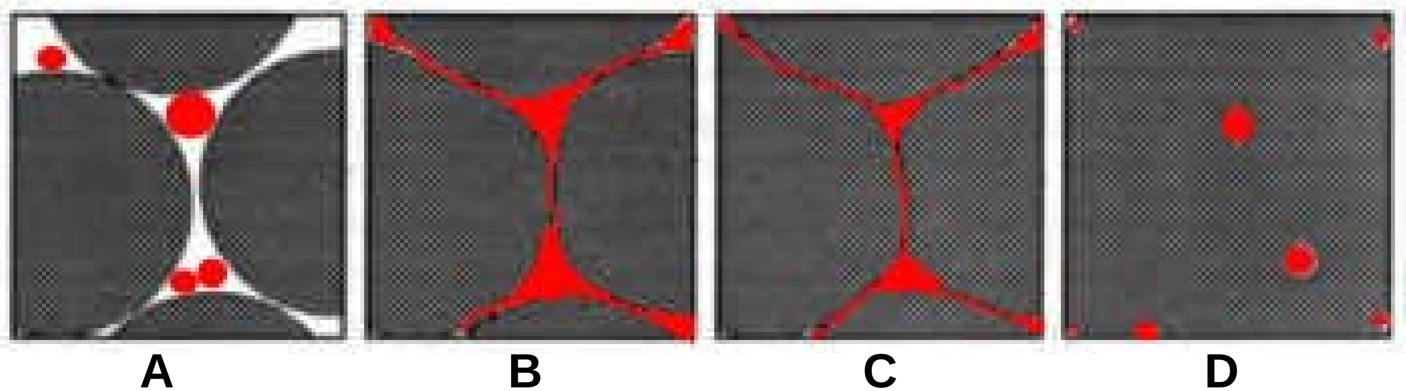
- Compaction





Powder Metallurgy

- Stages of sintering
  - » Point contact (A)
  - » Initial stage (B)
  - » Intermediate stage (C)
  - » Final stage (D)



Research on Mg P/M

- Utilizing rapid solidification to produce unique alloys and fine grain structures
- High strain rate superplasticity
- Investigation of mechanical properties and formability

- Canned powder hot extrusion

Objective

- Determine optimum conditions for the industrially dominant uni-axial die compaction process to produce magnesium alloy components via powder metallurgy

Methodology

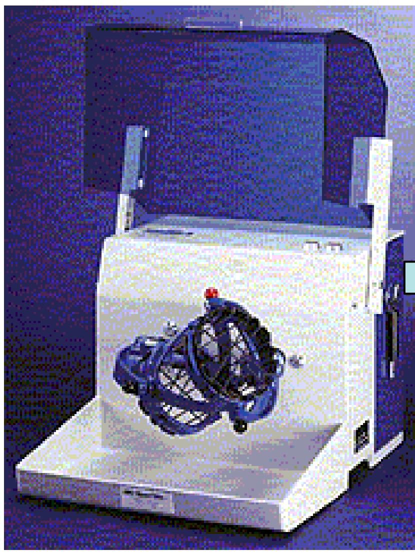
- Choose alloying elements
- Powder characterization
- Experimental design
  - Compaction pressure
  - Sintering temperature
  - Sintering time
  - Quench temperature

Methodology

- Characterize samples
  - Dimensional change
  - Density
  - Hardness
  - Microstructure
  - Chemical composition
  - Tensile properties

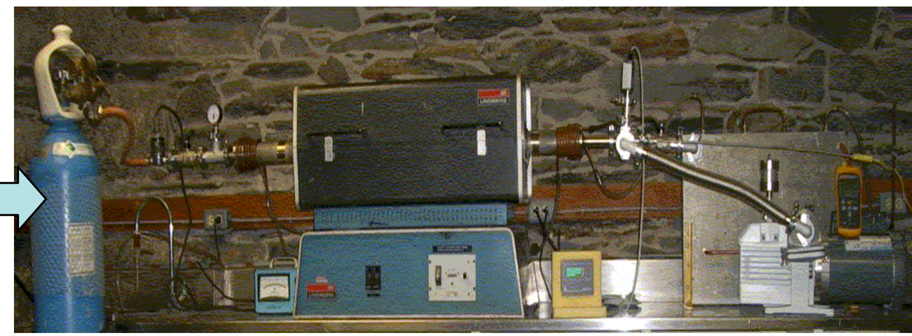
Experimental Procedure

Blending



Compacting

Sintering



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Experimental Procedure

- Alloy - AZ31 (3% Al, 1% Zn)
  - Determine optimum process conditions
- Pure Magnesium
  - Fundamental sintering behaviour

Experimental Procedure

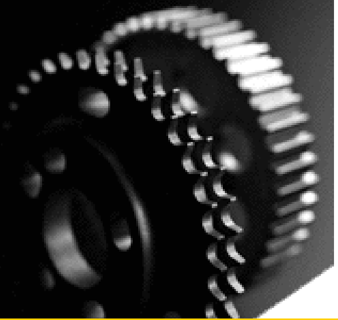
- Pure Mg
  - Sieve powder into similar size categories
  - Compact with isostatic and uniaxial press
  - Sintering time and temperature

Experimental Procedure

- AZ31

- Experimental plan constructed to allow analysis with design of experiments (DOE) principals

  - Compaction Pressure
    - 300, 400, 500 MPa

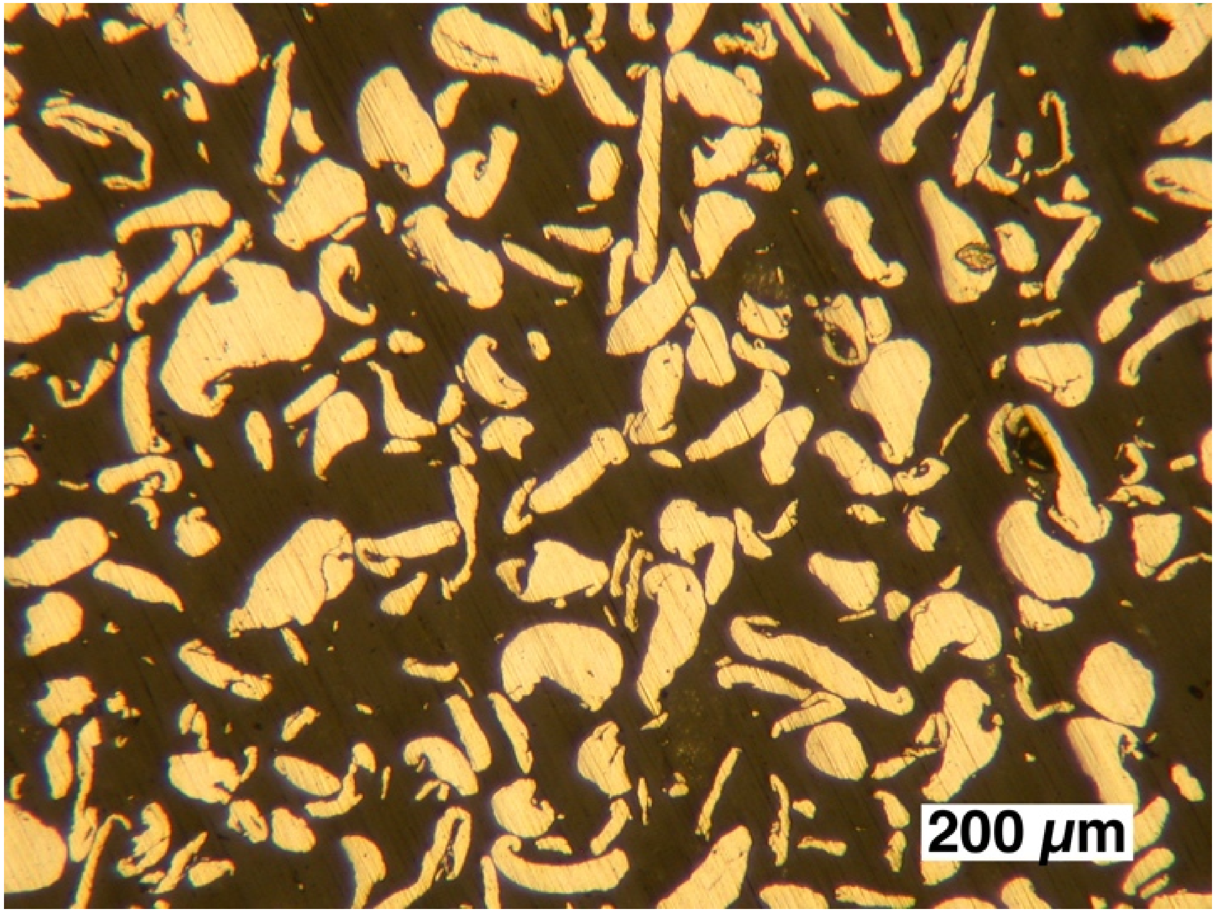


Experimental Procedure

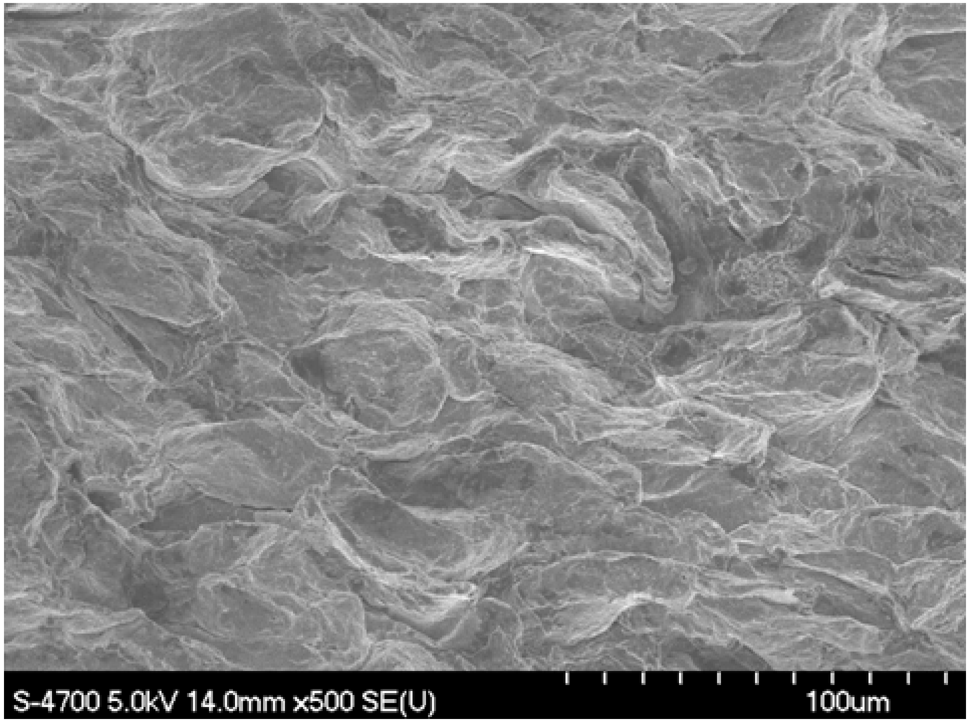
- Sintering Temperature
  - 500, 550 and 600ºC
- Sintering Time
  - 20, 40, 60 minutes
- Quench Temperature
  - 375ºC and 450ºC

Results - Pure Mg

Mg	98.6 %
MgO	1.32 %
Other	0.08 %

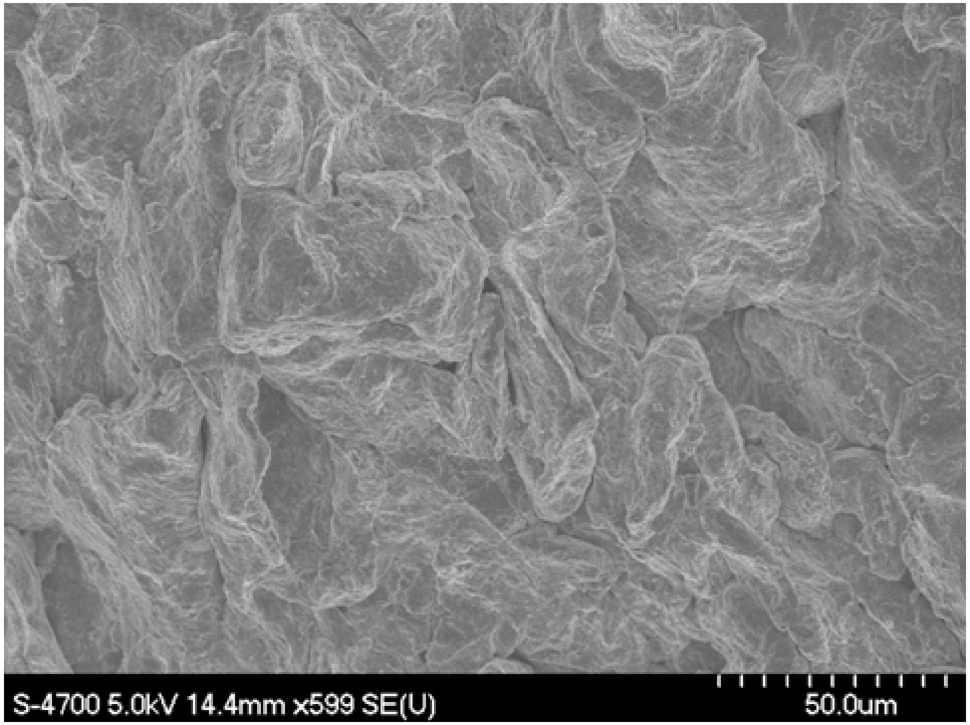


Results - Pure Mg



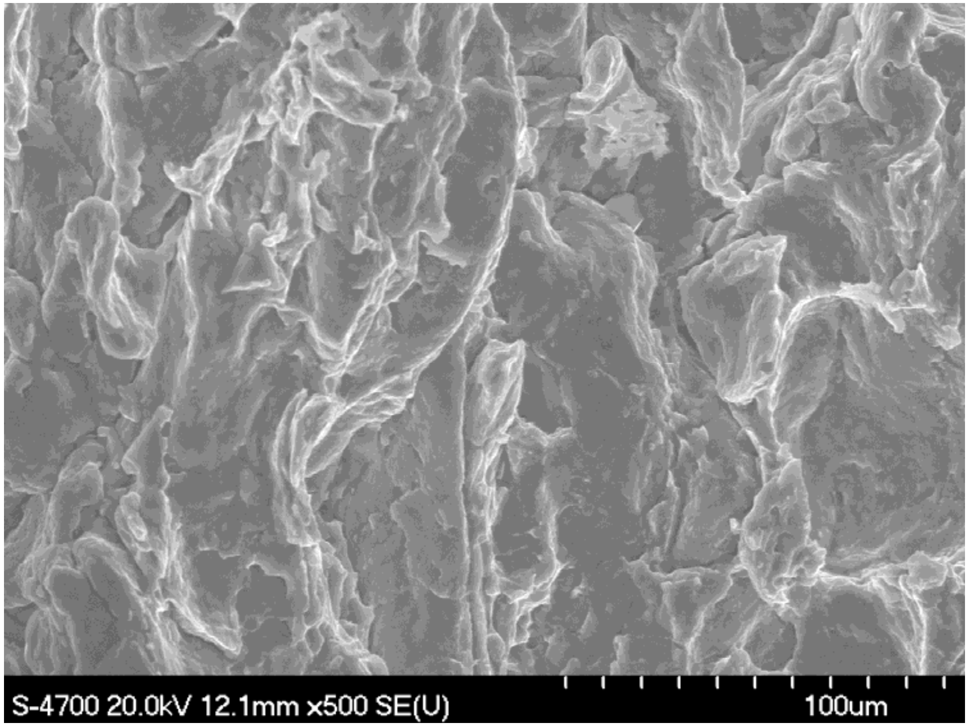
- Green sample, 500 MPa compaction

Results - Pure Mg



- 500 MPa compaction, sintered 500ºC for 30min

Results - AZ31



- 500 MPa compaction, sintered 550ºC for 20min, quenched 450ºC

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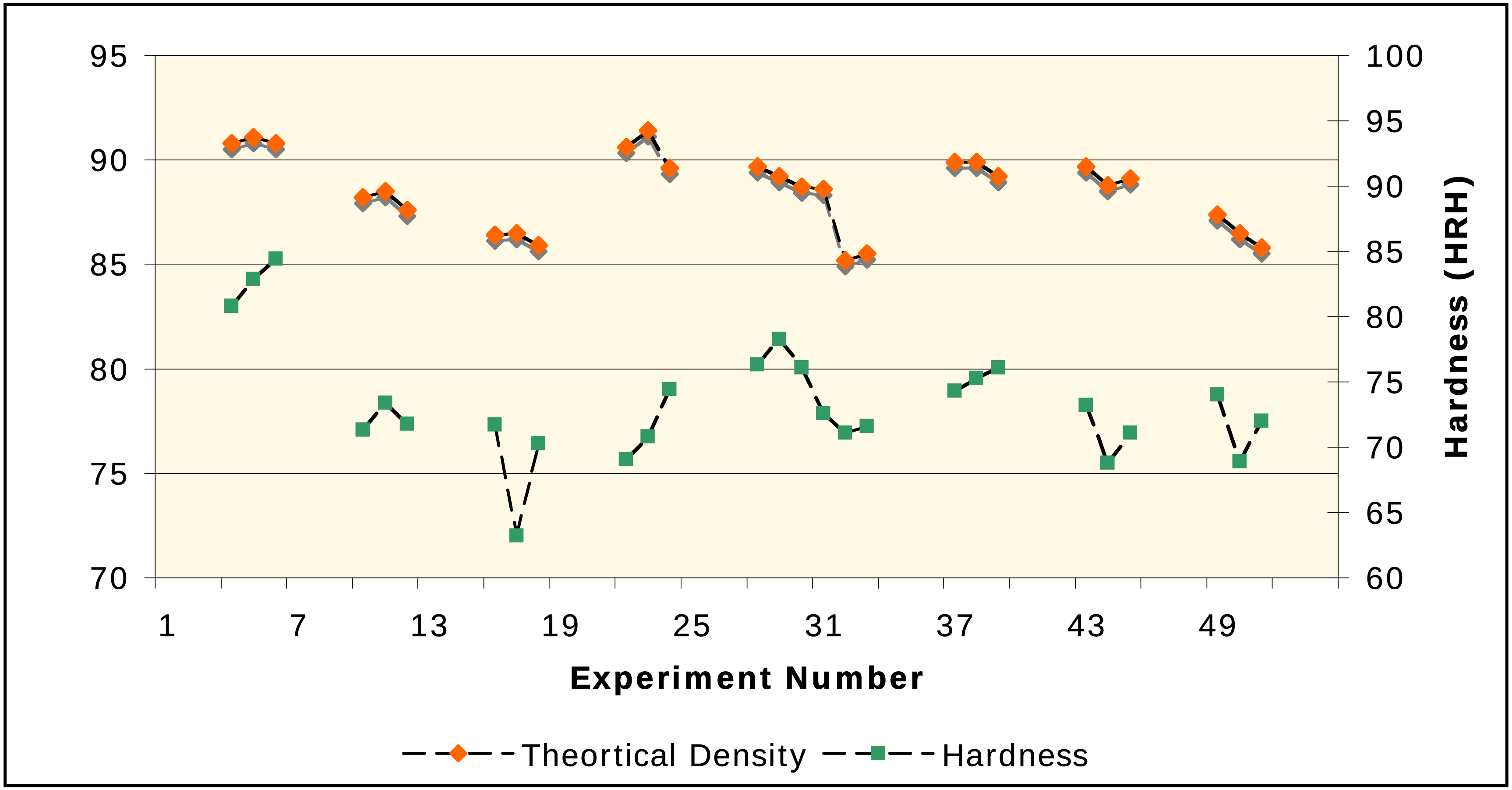
Results - AZ31



Results

- Quantitative EDS shows presence of Carbon and Oxygen in samples

Element	Weight%	Atomic%
C K	15.03	25.62
O K	8.40	10.75
Mg K	72.26	60.87
Al K	3.17	2.40
Zn K	1.14	0.36
Totals	100.00	

- X-Ray analysis of pure Mg samples shows no other elements

Conclusions

- Magnesium P/M has great potential
- Use of uni-axial die compaction relates to industrial applications
- Mechanical properties of ~90% dense PM samples similar to wrought product

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