## Galaxy Trade and Technology

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Presentation at Battery Electric Vehicle Architectures Congress, Detroit Michigan; February 2020



## Panoz Engineering





the line 1/2 c



- the lightest structural metal
- eighth most common element
- 2/3 density of aluminum
- 1/2 density of iron





- symmetric, hexagonal crystal structure:
- bonds easily with other elements;
- alloys with zinc, nickel, manganese, silicon, copper, zirconium, rare earths





- American Society for Metals defines >60 standard Mg alloys
- each with specific physical properties
- includes alloys with superior porosity, low-temperature die-casting, lower deformation, corrosion, fatigue



ASTM	EN Standard	
	Symbol	Number
AZ81	EN-MCMgAl8Zn	EN-MC21110
AZ91	EN-MCMgAl9Zn1(A)	EN-MC21120
AM60	EN-MCMgAl6Mn	EN-MC21230
AS41	EN-MCMgAlSi	EN-MC21320
EQ21	EN-MCMgRE2Ag1Zr	EN-MC65220
EZ33	EN-MCMgRE3Zn2Zr	EN-MC65120
QE22	EN-MCMgRE2Ag2Zr	EN-MC65210
WE43	EN-MCMgY4RE3Zr	EN-MC95320
WE54	EN-MCMgY5RE4Zr	EN-MC95310
ZC63	EN-MCMgZn6Cu3Mn	EN-MC32110
ZE41	EN-MCMgZn4RE1Zr	EN-MC35110

Similar magnesium alloy designations

Table 3







- includes high stiffness-to-weight, machinability, excellent damping
- Galaxy has custom alloy design capability, micro-alloying using nano process





- 20% lighter than aluminum 40% lighter than steel
- for automobiles: focus on lightweighting
- with no compromise in physical performance or safety





# American Society for Metals: asminternational.org



## http://j.mp/Magnesium-Brief (pdf)



# The issues:

"Magnesium has the lowest density of metals used in cars and is currently used primarily in the powertrain...because it's easier to work with than other lightweight materials, it could see a resurgence in use.

However, it is expensive, lacks crashworthiness and is not readily available in large quantities.

... 3M Corporation, <u>http://bit.ly/3M-adhesive</u>









# The issues:



- misconceptions: crashworthiness heat instability
- expensive not readily available in large quantities



heat instability correctly-designed Mg alloys are safe and stable at high heat, do not ignite



### crashworthiness

alloy design; superior toughness, resistance



expensive



- Galaxy has direct access to mines,
- refining, alloy fabrication;
- reduces complex supply chain markup

## not readily available in large quantities

Galaxy has current capacity of 20K metric tonnes/mo., expandible to 40K

### production methodologies

Introduce production methodologies and applications that exploit material attributes.



(USGS)



- China has 70% of world's current commercially mineable magnesium
- 350 years reserves
- Galaxy has access to 15 major mines in Shaanxi province
- 20% of world supply





- Galaxy has made a major commitment to the automotive industry:
- lightweighting, high-performance, alloy design, compatible parts design:
- "magnesium optimization"

### mining • manufacturing • science • logistics • finance

### Magnesium It's Elemental

An integrated global magnesium ecosystem



Vehicles

Aerospace

Pharma



Construction

Filtration

galaxytradetechnology.com



A USA-China joint venture 星河镁科工贸公司

"An intersection of geological, industrial and elemental anomalies spells economic opportunity ... "



"Magnesium answers the urgent global need for lighter, environmentally-sound technology."

### galaxytradetechnology.com

### Galaxy Trade and Technology



serving the automotive industry

Auto racing E

Engineering







Batteries

Greentech

galaxymagnesium.com

## The Galaxy Way: Responsible Corporate Citizenship Green from Beginning to End

Mining and Refining: Galaxy operations powered by renewable energy

Less energy to recycle and reuse: lower melting point for magnesium

Magnesium: lower melting point than aluminum, iron: less energy to manufacture

> Magnesium Automotive Energy Life Cycle

Electric Vehicle operation produces 43% lower emissions (average) for 20-year vehicle life; > 100,000 pounds carbon savings



Electric power utility operated by Galaxy partner; solar, wind, biomass

Transportation: by ship and rail, advanced conservation strategies



## Dong Yuming

Chairman of Galaxy Trade and Technology China; based in Xi'an

by video conference



## Dong Yuming speaking from Xi'an

I am pleased to join you in Detroit today.

Just three and a half months ago, I met some of you personally at the auto lightweighting conference in Atlanta. We learned much useful information there, and those opportunities set the stage for today's event, together with our friend Dan Panoz.

I am the CEO of Galaxy Trade and Technology of China, based in Xi'an, and work closely with Zhou Xiaofang and her husband, Michael North and their international team to build a world-class magnesium export company that can share this great natural resource with all nations, especially America and Europe.



## Dong Yuming speaking from Xi'an

As an engineer, I follow the rapidly expanding uses of magnesium. We are always developing new techniques, which include novel uses of magnesium compounds and alloys that are difficult to match with any other mineral. One special area of interest to me is micro-alloying, using nano technology to create new precision alloys.

I look forward to sharing that capability with you.

I am fortunate to live near the center of the biggest magnesium producing mines in the world, to know the people who run them, and to help connect their genius, hard work and initiative to global markets.



## Dong Yuming speaking from Xi'an

On behalf of Galaxy, and all the people of Shaanxi Province, I invite you to visit us, to discuss mutually-beneficial opportunities, to share our culture and history, and to develop solid, longlasting business together that benefits the people of America, and the people of China.





## Qiu Ruimin



## President of Magnesium Alloy Technology Innovation Center, Yulin, China

by video conference

I would like to introduce you to the Yulin magnesium industry.

Yulin is a city in northern Shaanxi Province, China with potential mineral resources valued at about \$650 million US dollars. Our raw magnesium output is 420,000 metric tonnes per year, which accounts for approximately 41% of the world's supply.

My organization, Yulin Magnesium and Alloy Technology Innovation, is the supporter, promoter and often investor in the magnesium industry, representing the local and provincial government.



![](_page_21_Picture_5.jpeg)

We have signed a Memorandum of Understanding with Galaxy Trade and Technology, the China-US joint venture. We work closely with them and fully support their goal -- to bring magnesium exports to the world in a spirit of service and excellence.

That's why I'm here with you today.

Energy conservation is a major priority for electric vehicles, and automobile lightweighting is a practical strategy for achieving this goal. This provides a good basis for our long-term friendly cooperation. We are building a lightweight industrial ecosystem, based on magnesium and aluminum.

![](_page_22_Picture_4.jpeg)

Our key capabilities include sufficient supply, price advantage and support of the government.

1. Sufficient supply is guaranteed. China is the most important magnesium-producing country in the world, and Yulin is the main magnesium producing area in China. Through many years of investment and hard work, we have developed a clear high-capacity production advantage.

2、Because of this high capacity, we also have a price advantage. Magnesium production requires large amounts of electrical energy. Through a combination of renewable energy and abundant coal resources, we have reduced our operating costs, and are able to offer significant price advantage to world markets.

![](_page_23_Picture_4.jpeg)

3. The Yulin Municipal government attaches great importance to the magnesium industry. They have designated \$100 billion, phased over several years and made available through a series of preferential policies. We support research and development technology projects, including smelting, plastic processing and magnesium alloy technology.

Our next step is to attract investment to build a professional, large-scale magnesium industrial cluster, and we are working with Galaxy on that.

![](_page_24_Picture_3.jpeg)

We sincerely welcome all kinds of enterprises, to visit Yulin and discuss friendly co-operation based on mutual respect and equality.

Greetings to all our friends in Detroit, and across America!

![](_page_25_Picture_3.jpeg)

![](_page_26_Picture_0.jpeg)

# Dan Panoz

founder of Panoz Engineering, built small American auto manufacturer for three decades

successful in business, engineering, design, and winning world-class competitive auto races

working with Galaxy on magnesiumoptimization strategies

## The starting line... This is what it looks like to compete against the world's best automotive companies!

Audi..BMW..Chevrolet..Porsche..Mercedes AMG..Ginetta..Mc Claren..Maserati..KTM-X..SIN

![](_page_27_Picture_2.jpeg)

## Panoz has done this for over 22 years

![](_page_27_Picture_4.jpeg)

![](_page_28_Picture_0.jpeg)

## Manufacturers who Compete in SRO in 2020

![](_page_28_Picture_2.jpeg)

ASTON MARTIN

![](_page_28_Picture_4.jpeg)

![](_page_28_Picture_5.jpeg)

![](_page_28_Picture_6.jpeg)

![](_page_28_Picture_7.jpeg)

![](_page_28_Picture_8.jpeg)

![](_page_28_Picture_9.jpeg)

![](_page_28_Picture_10.jpeg)

![](_page_28_Picture_11.jpeg)

![](_page_28_Picture_12.jpeg)

![](_page_28_Picture_13.jpeg)

![](_page_28_Picture_14.jpeg)

![](_page_29_Picture_0.jpeg)

## 2019 Champions

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![](_page_29_Picture_3.jpeg)

![](_page_29_Picture_4.jpeg)

![](_page_29_Picture_5.jpeg)

![](_page_29_Picture_6.jpeg)

## Win with Panoz Racing

## 2019 Champions

![](_page_29_Picture_9.jpeg)

![](_page_29_Picture_10.jpeg)

![](_page_30_Picture_0.jpeg)

## 2018 Champions

![](_page_30_Picture_2.jpeg)

### Pirelli GT4 AMERICA - SPRINT **380 GTS COMBINED CHAMPIONSHIP**

![](_page_30_Picture_4.jpeg)

2018 TEAM PANOZ RACING

![](_page_30_Picture_7.jpeg)

![](_page_30_Picture_8.jpeg)

![](_page_30_Picture_9.jpeg)

## 2018 Champions

![](_page_30_Picture_12.jpeg)

![](_page_30_Picture_13.jpeg)

![](_page_31_Picture_0.jpeg)

## 2017 Championship

![](_page_31_Picture_2.jpeg)

![](_page_31_Picture_3.jpeg)

![](_page_31_Picture_4.jpeg)

![](_page_31_Picture_5.jpeg)

![](_page_31_Picture_6.jpeg)

![](_page_31_Picture_7.jpeg)

![](_page_31_Picture_8.jpeg)

### 2ND MANUFACTURES CHAMPIONSHIP

## 2017 Championship

![](_page_31_Picture_12.jpeg)

### **3RD GTS PRO DRIVER CHAMPIONSHIP**

![](_page_31_Picture_14.jpeg)

Pirelli GT4 AMERICA - SPRINT 2017 **TEAM PANOZ RACING** 

![](_page_31_Picture_16.jpeg)

![](_page_31_Picture_17.jpeg)

## Panoz Design, Engineering and Manufacturing

50 miles north of Atlanta, Braselton GA 200,000 sq. ft.-- executive offices, design, prototyping, manufacturing and assembly space

Penoz

Desta

![](_page_32_Picture_2.jpeg)

![](_page_32_Picture_3.jpeg)

![](_page_33_Picture_0.jpeg)

## Vehicles

![](_page_33_Picture_2.jpeg)

# Mg Optimization

![](_page_33_Picture_7.jpeg)

- **Panoz Engineering:**
- New vehicle design
- 55 subsystems determined to be candidates for magnesium optimization

![](_page_33_Picture_11.jpeg)

![](_page_34_Picture_0.jpeg)

## Vehicles

![](_page_34_Picture_2.jpeg)

## **Assumptions:**

replacing aluminum parts: 20% lighter weight

replacing steel parts: 35% lighter weight

# Mg Optimization

![](_page_34_Picture_8.jpeg)

both using magnesium alloys

![](_page_35_Picture_0.jpeg)

## Vehicles

![](_page_35_Picture_2.jpeg)

long-term: Mg batteries, Mg-assisted solar augmentation

# Mg Optimization

![](_page_35_Picture_6.jpeg)

take "low-hanging fruit" approach:

the easiest to optimize first, requiring least re-design, re-tooling

later -- medium difficulty: heavy structural elements, casings

![](_page_36_Picture_0.jpeg)

![](_page_36_Picture_1.jpeg)

Super-Plastic Formed (SPF) Exterior Structures & Inner Structures Stamped Matched Die for Inner and Outer Structure

### Floor Pans / Bulkhead Assemblies (FBA)

- Modular floor pans / Bulkheads SPF Stamped Matched Die for Inner and Outer Structure Modular Multi-Celled Main Chassis
- Chassis Rails Supports, Cast
- Chassis Rails, Stamped

### **Crash Structures**

- Front / Rear / Side Crash Structures, Exterior
- Extruded
- 11. Stamped
- 12. Hybrid / Stamped / Cast / Sheet

preliminary study: Panoz Engineering/Galaxy Trade and Technology © copyright 2019-2020

![](_page_36_Picture_13.jpeg)

![](_page_37_Picture_0.jpeg)

### **Cross Members**

- **Suspe** Rear 17 18 19 20

### Suspension / Forged / Cast / Hybrid

# GALAN

- 13. Cross Members All
- 14. Modular Extruded
- 15. Formed Sheet
- 16. Hybrid = Formed / extruded / cast

### Suspension & Drivetrain Subframe (SDS) Front /

- 17. SDS, Modular Extruded
- 18. SDS, Cast
- 19. SDS, Stamped
- 20. SDS, Hybrid
- 21. Upper Control Arms
- 22. Lower Control Arms
- 23. Uprights
- 24. Hubs
- 25. Caliper Brackets

![](_page_37_Picture_21.jpeg)

![](_page_38_Picture_0.jpeg)

### **Batteries**

- 32. Battery Pack Mounting Points 32 Battery Control Housings

Wheels / Modular

- 26. Rim
- 27. Centers

### **Fuel Tanks**

- 28. Inner and Outer
- 29. Energy Material
- 30. Battery Cases
- 31. Battery Pack Enclosures

### Engine / Related

- 34. Block
- 35. Heads
- 36. Intake
- 37. Brackets
- 38. Alternator Housings
- 39. Pump Housings

![](_page_38_Picture_23.jpeg)

![](_page_38_Picture_24.jpeg)

![](_page_39_Picture_0.jpeg)

- 40. Transmission Housings 41. Trans Axles 42. Transfer Case 43. Differential Housings 44. Housings
- 45. Bellhousings and Adapters 46. Flywheels
- **Transfer Cases / Power Take Offs** 
  - 47. Housings 48. Driveshafts

### Vehicle Controls

- 49. Steering Columns
- 50. Pedal Assemblies
- 51. Instrument Package Frames
- 52. Lighting Housings
- 53. Latches
- 54. Hinges
- 55. Décor / Trim

![](_page_39_Figure_14.jpeg)

![](_page_39_Picture_15.jpeg)

![](_page_40_Picture_0.jpeg)

![](_page_40_Picture_1.jpeg)

techniques.

# Mg Optimization

![](_page_40_Picture_8.jpeg)

- limitations of the model:
- These models take "LHF" approach only
- **Projected Costs** = Competitive pricing with other commonly used alloys.
- **Objectives**: Assess degree of lightweighting possible within established manufacturing
- Amount of magnesium needed

![](_page_41_Picture_0.jpeg)

## preliminary conclusions:

- weight reduction with magnesium optimization is significant:
- 26% vs. Steel alloys
- 3931 lbs. GVW vs. 5303 lbs. GVW

![](_page_42_Picture_0.jpeg)

## preli 1088 50% 28% vehic

## preliminary conclusions:

- 1088 Lbs. of magnesium, in est. 50% alloy format, required per vehicle
- 28% of GVW in magnesium-optimized vehicle is Mg

### Engineering

## Design

# Greentech

## Panoz Design and Engineering Principles

![](_page_43_Picture_8.jpeg)

- Reliability / Value / Performance
- Specializing in Lightweight construction with aluminum alloys and advanced composites for over 25 years.
- Modular Construction
- Lean Capital Requirement Techniques

![](_page_43_Picture_15.jpeg)

### Engineering

## Design

## Greentech

## Panoz Design and Engineering Principles

weighting

Consistent high achievement in safety, Certification & Homologation

![](_page_44_Picture_6.jpeg)

![](_page_44_Picture_7.jpeg)

![](_page_45_Picture_0.jpeg)

## Co-Operation

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- Galaxy-Panoz applied research in magnesium optimization:
- will be openly shared with the automotive design community
- Through independent non-profit organization meeting annually:

### **Flying Tigers Institute**

dedicated to heroic US-China History in WWII

![](_page_46_Picture_0.jpeg)

![](_page_46_Picture_4.jpeg)

## Magnesium Health

- Put some magnesium in your vehicles... And put some in your body, too!
- Galaxy offers BEVA conference guests a healthy snack, rich in natural magnesium.
- Magnesium is key to a healthy heart, nervous system, digestion, stress management and a strong immune system.

## Galaxy Trade and Technology

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