GISS TECHNOLOGY

"HISTORY, PRESENT, AND FUTURE"

Assoc. Prof. Dr. Jessada Wannasin
Founder and CEO
GISSCO Co., Ltd.
Prince of Songkla University

ABOUT ME

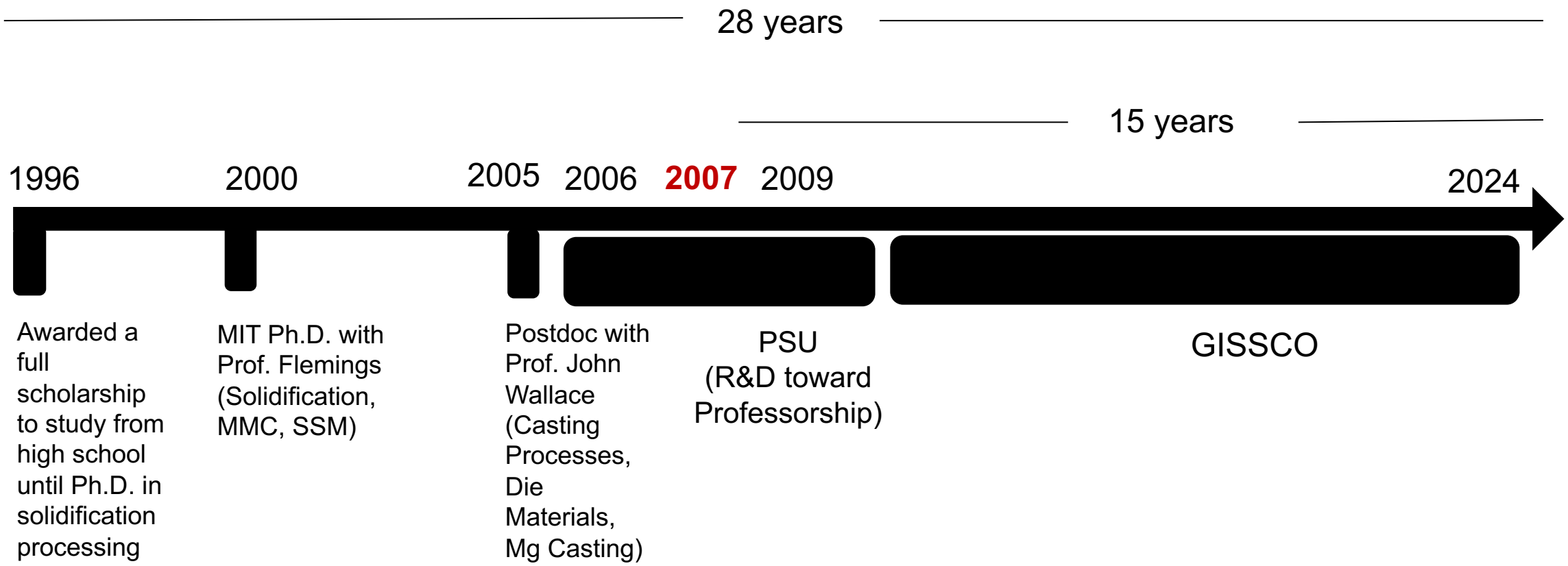
CEO, GISSCO

CEO, ColoriS Technology

Associate Professor, Prince of Songkla University

Executive Board Member

ABOUT ME


28 years
15 years
1996
2000
2005
2006
2007
2009
2024
Awarded a full scholarship to study from high school until Ph.D. in solidification processing
MIT Ph.D. with Prof. Flemings (Solidification, MMC, SSM)
Postdoc with Prof. John Wallace (Casting Processes, Die Materials, Mg Casting)
PSU (R&D toward Professorship)
GISSCO

PRESENT

Advisory Board Members

Assoc. Prof. Dr. Jessada Wannasin

Founder and President

Prof. Dr. Merton C. Flemings

Co-Founder and Advisor

Massachusetts Institute of Technology

Marc Fuchs

Advisor

Eric Showalter

Advisor

Dr. Youfeng He

CTO and Global Sale Director

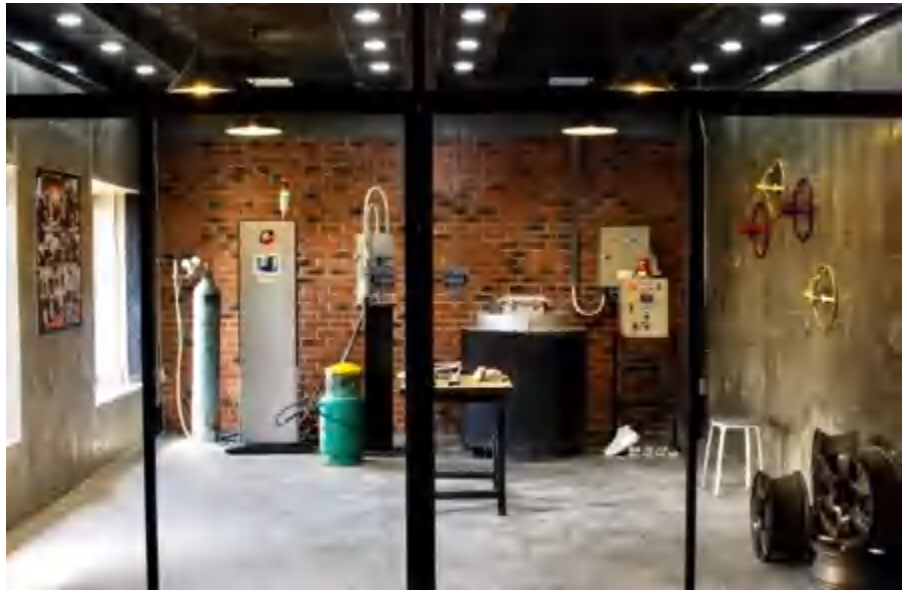
Dr. Edward Rubesch

VP Strategy

Dr. Sangop Thanabumrungkul

Managing Director

Headquarter @ Bangkok



R&D Center @ Songkhla

R&D Center @ Songkhla

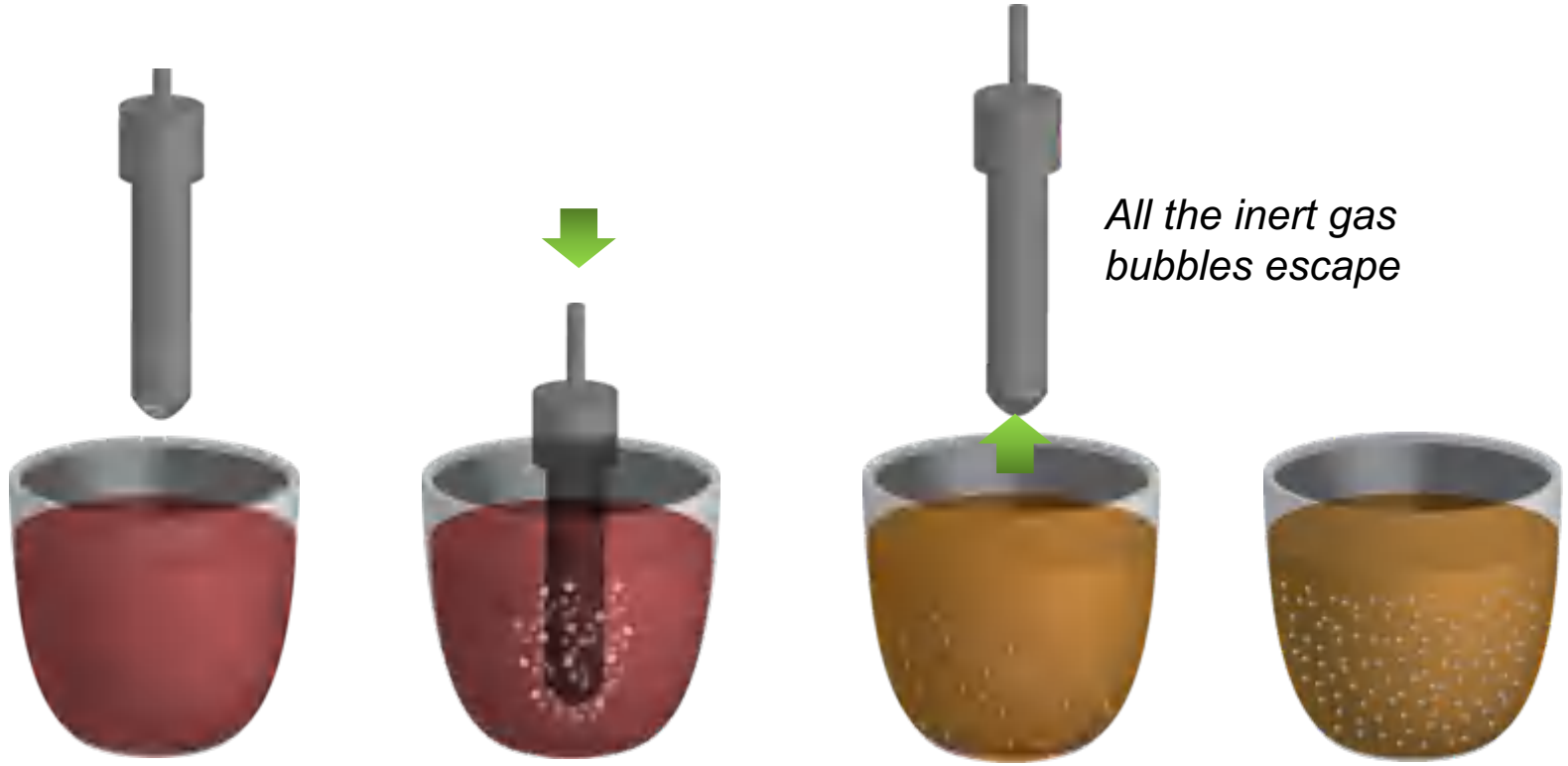
R&D Center @ Songkhla

HISTORY

History of GISS

Massachusetts Institute of Technology

Patented Technology by GISSCO



All the inert gas bubbles escape

Lowest temperature that can fill the die

International Patent Number: PCT/US2007/002503

Introduction to GISSCO

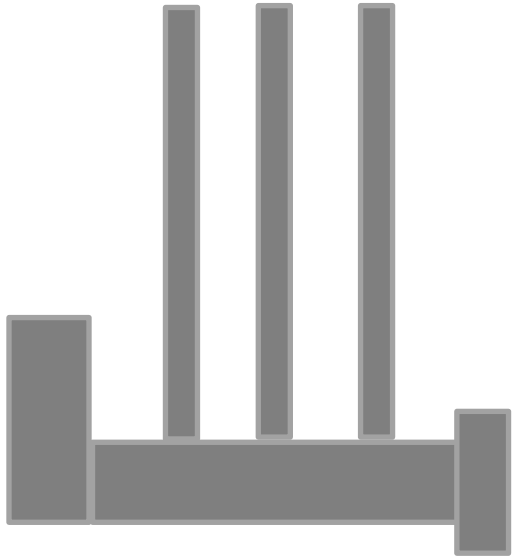
Startup of GISSCO, Co. Ltd. in 2009

Prof. Merton C. Flemings

Assoc. Prof. Dr. Jessada Wannasin

Massachusetts Institute of Technology

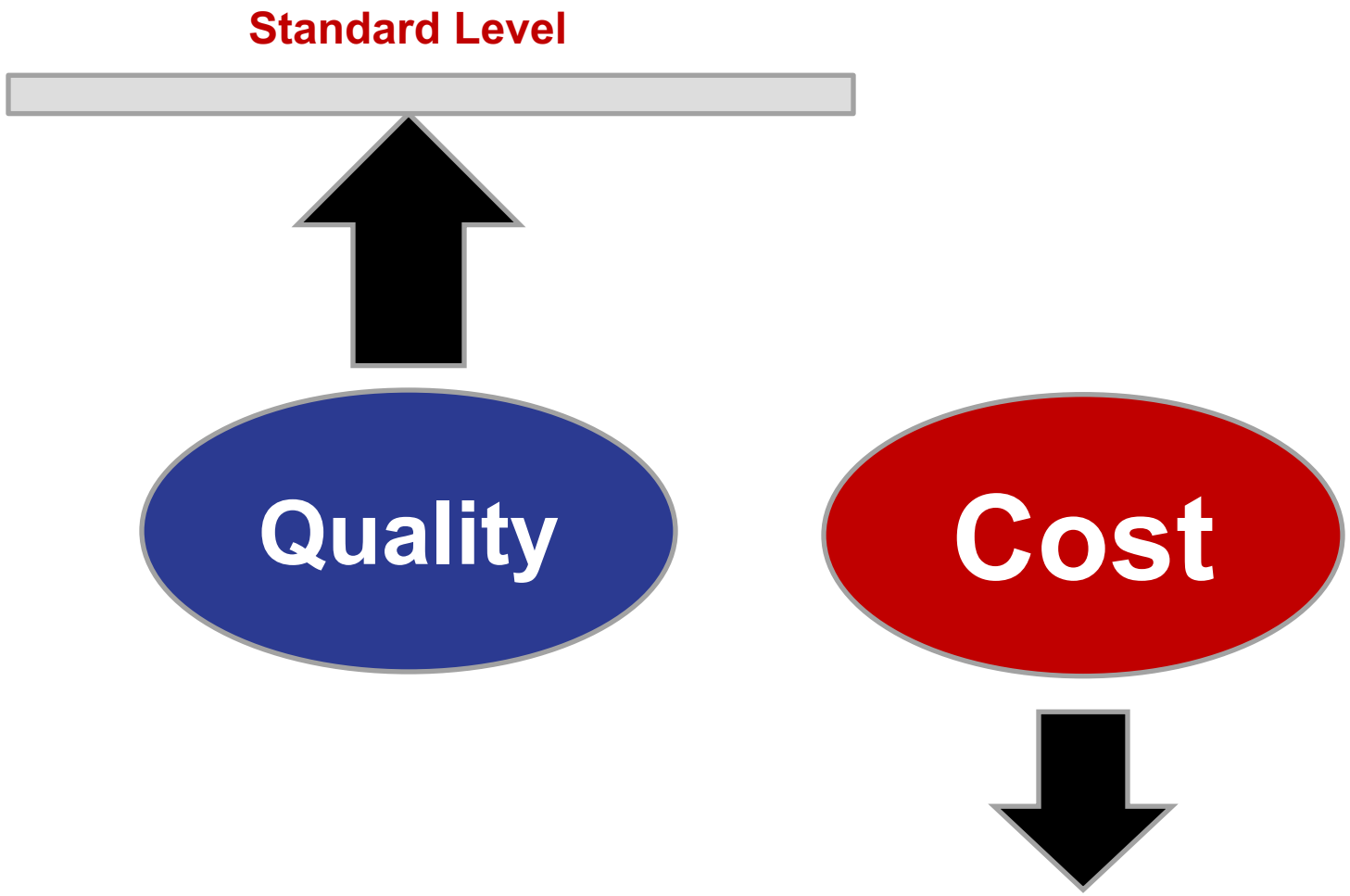
Experience from the Last 20 Years



- Forged steel
- Forged aluminum
- Machined aluminum
- 3D Printing aluminum
- Cast aluminum
  - LPDC
  - HPDC
  - GDC

Quality and Costs

Experience from the Last 20 Years



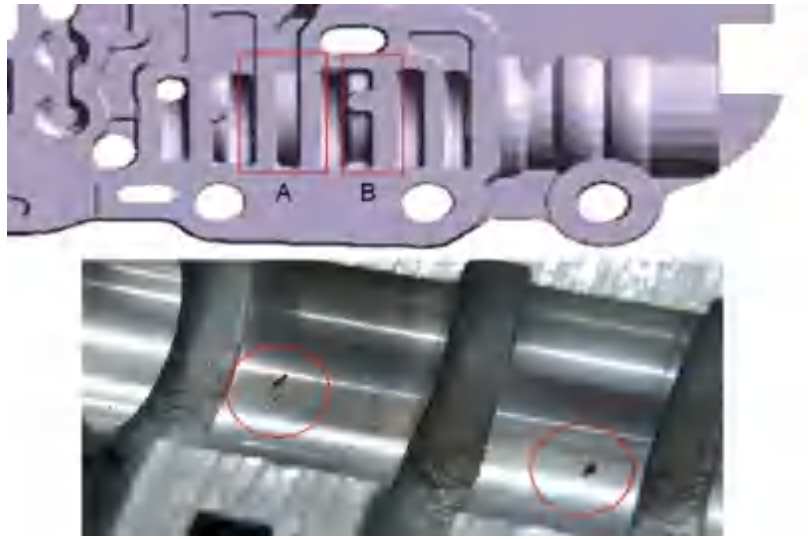
In the metal casting industry, the process with the lowest cost will win.

History

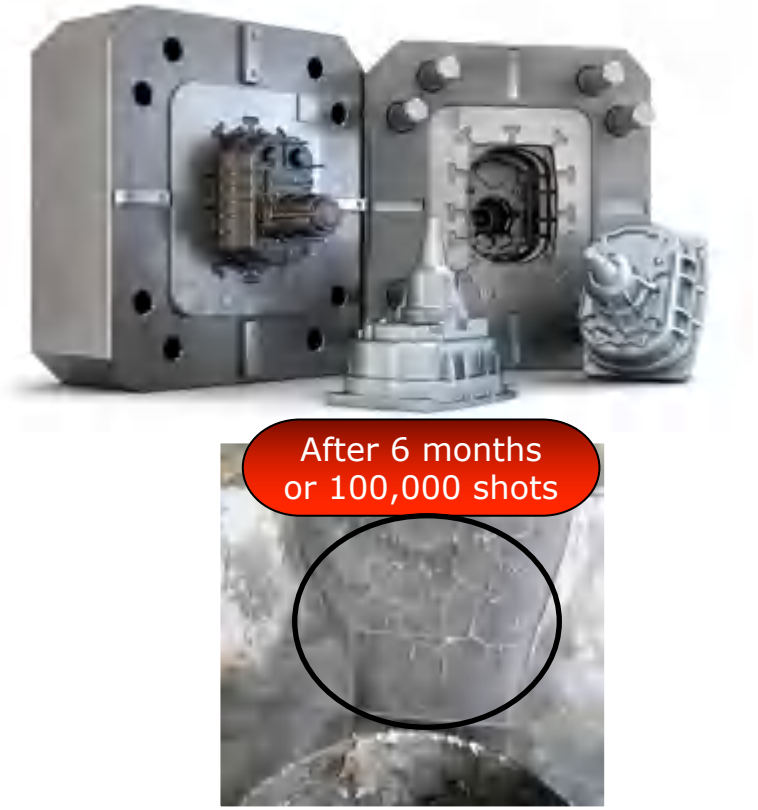
Metal Casting ~ 7,000 years

History

Porosity defects and die life issues remain!

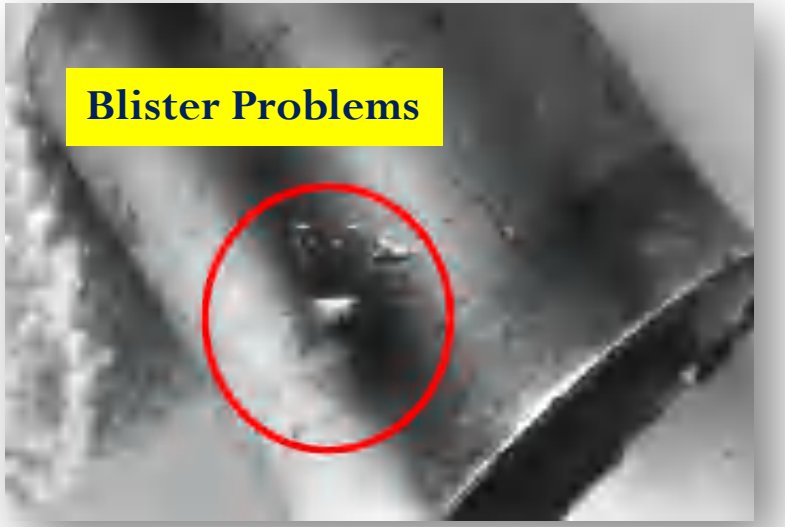


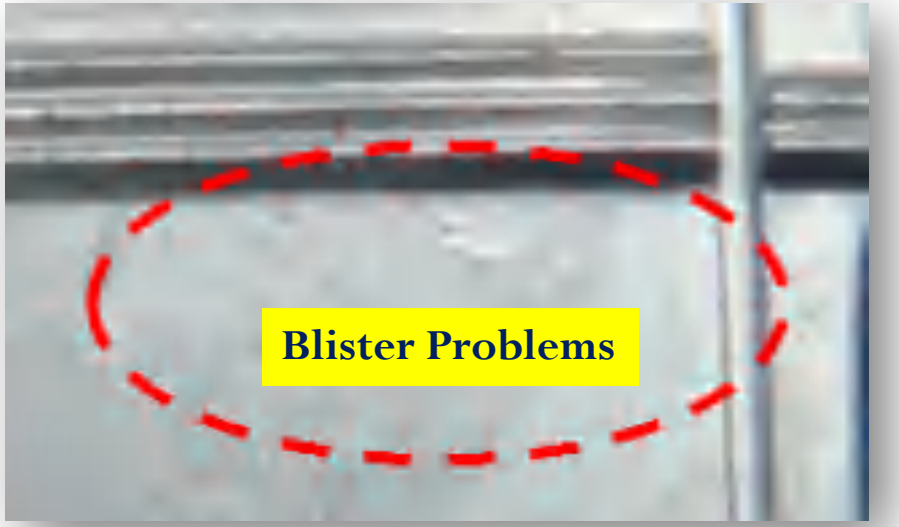
Porosity



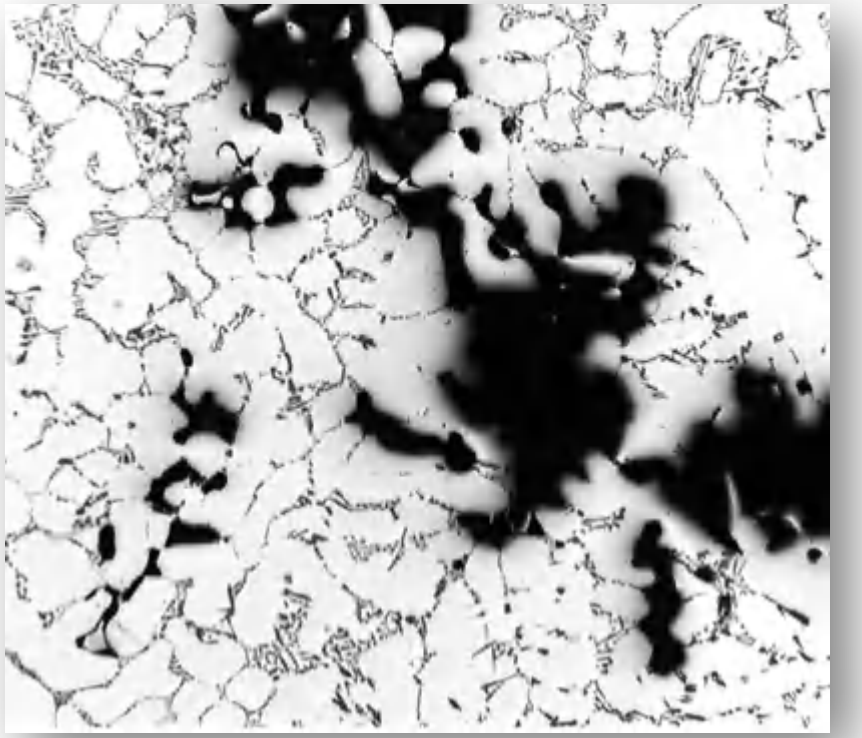
Die Life

Gas Porosity



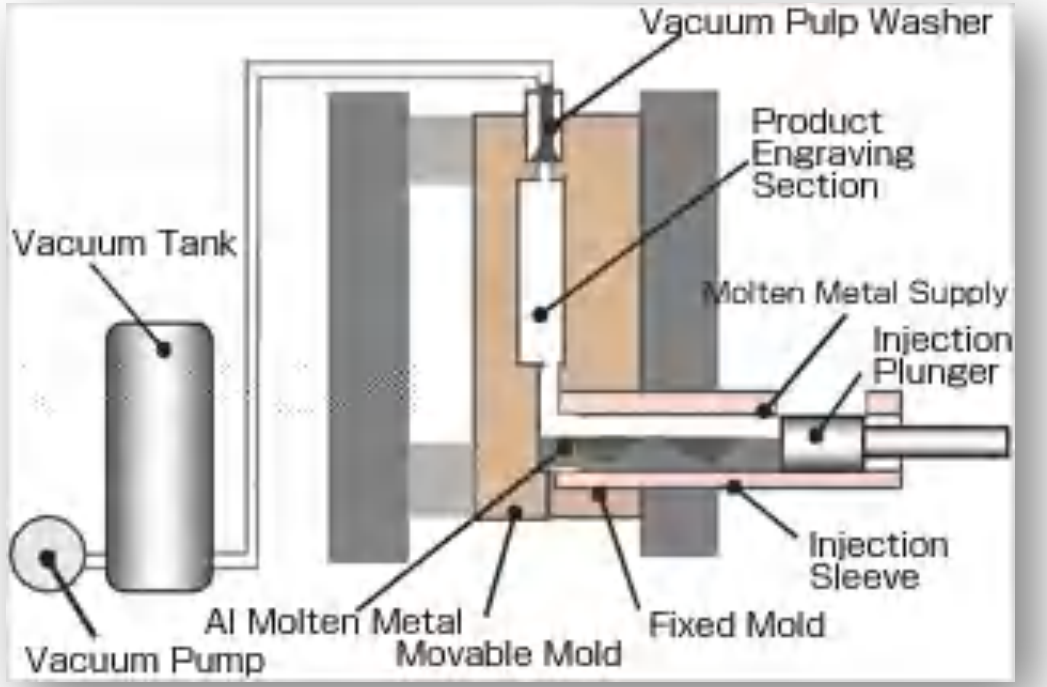


Shrinkage Porosity



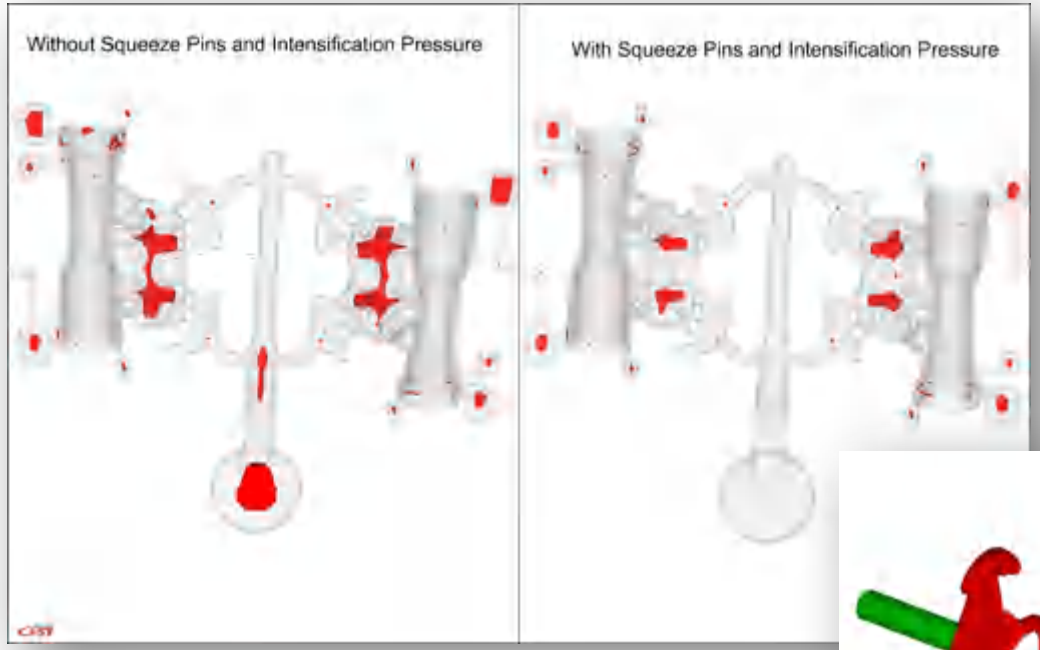
Pictures from the internet.

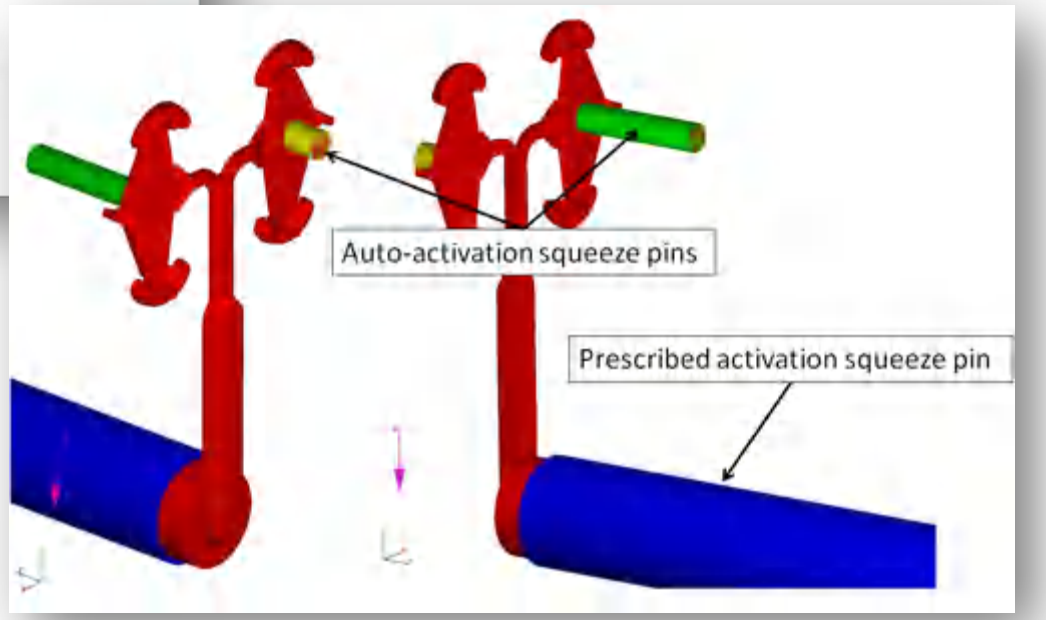
Vacuum Technology



Ref: Fondarex

Squeeze Pins

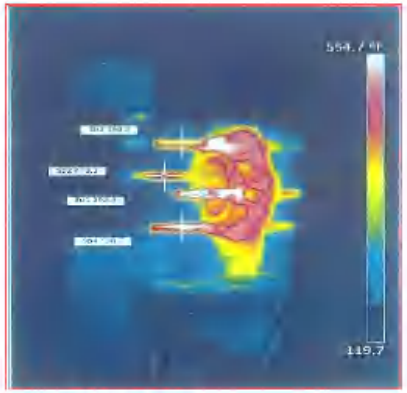




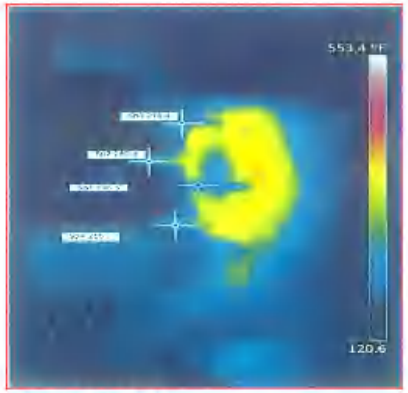
Ref: Flow-3D

Jet Cool

Thermal Control



Before CORECOOL



After CORECOOL

Shrink Porosity Control

Before CORECOOL

After CORECOOL

Ref: CORECOOL

A Breakthrough 50 Years Ago

Semi-Solid Forming

Semi-Solid Metal

Complex + Difficult to Control + Expensive

<<1%

Adoption by Industry

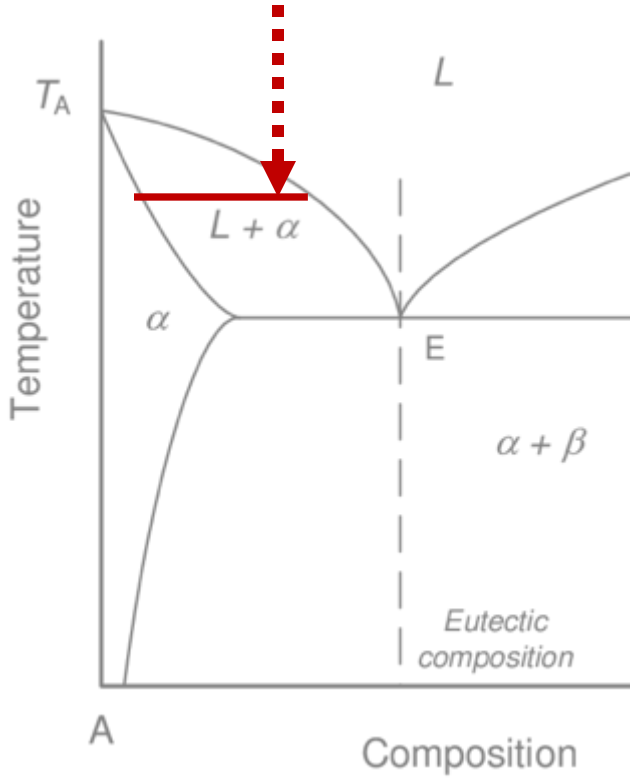
Pain Points

Cannot simply change the alloy

Cannot simply modify the HPDC machine

Cannot simply modify the die design

The Birth of Slurry Casting at about 15 Years Ago



Only applicable to some alloys

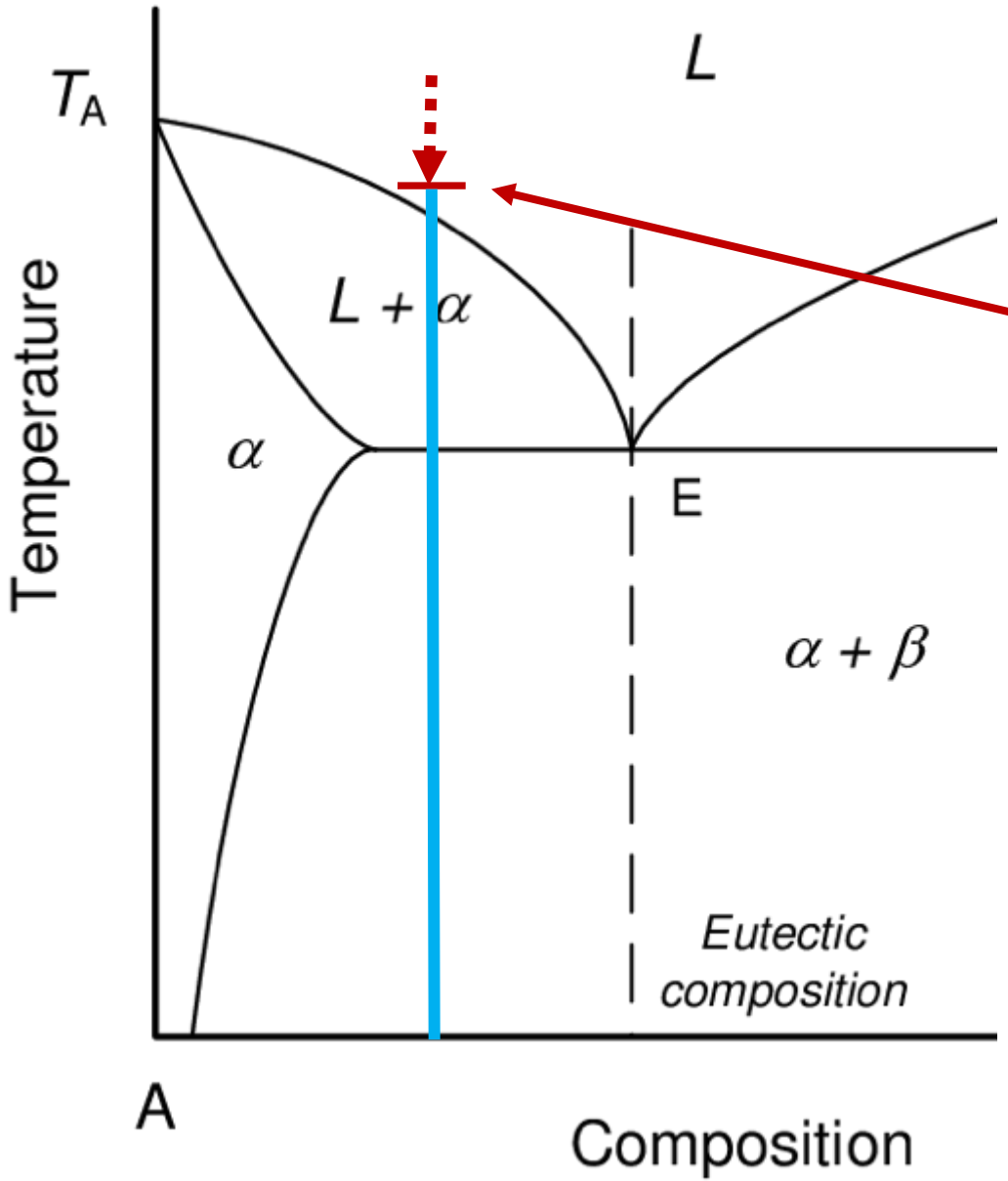
Slurry requires mold design modifications
=> Thicker gates to fill thin sections.

T_{Slurry} is in T_L and T_S range

THE BIRTH OF GISS (11 YRS AGO)

SUPERHEATED SLURRY PROCESS

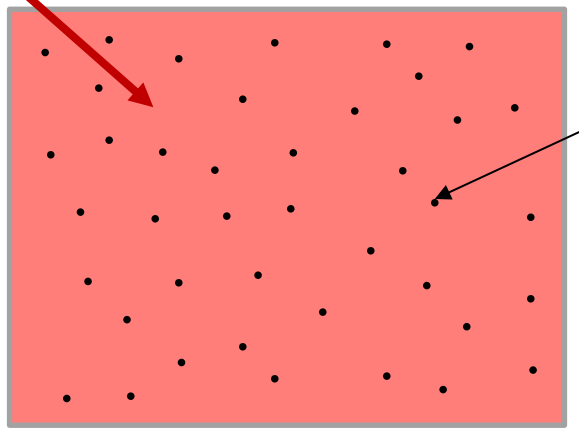
Superheated Slurry Principle



GISS

Gas Induced Superheated Slurry

T_{GISS} is above T_L



How is it possible?

The Birth of GISS: How It Works!

Kinetic Process

Superheated Slurry

Liquid

Superheated Slurry

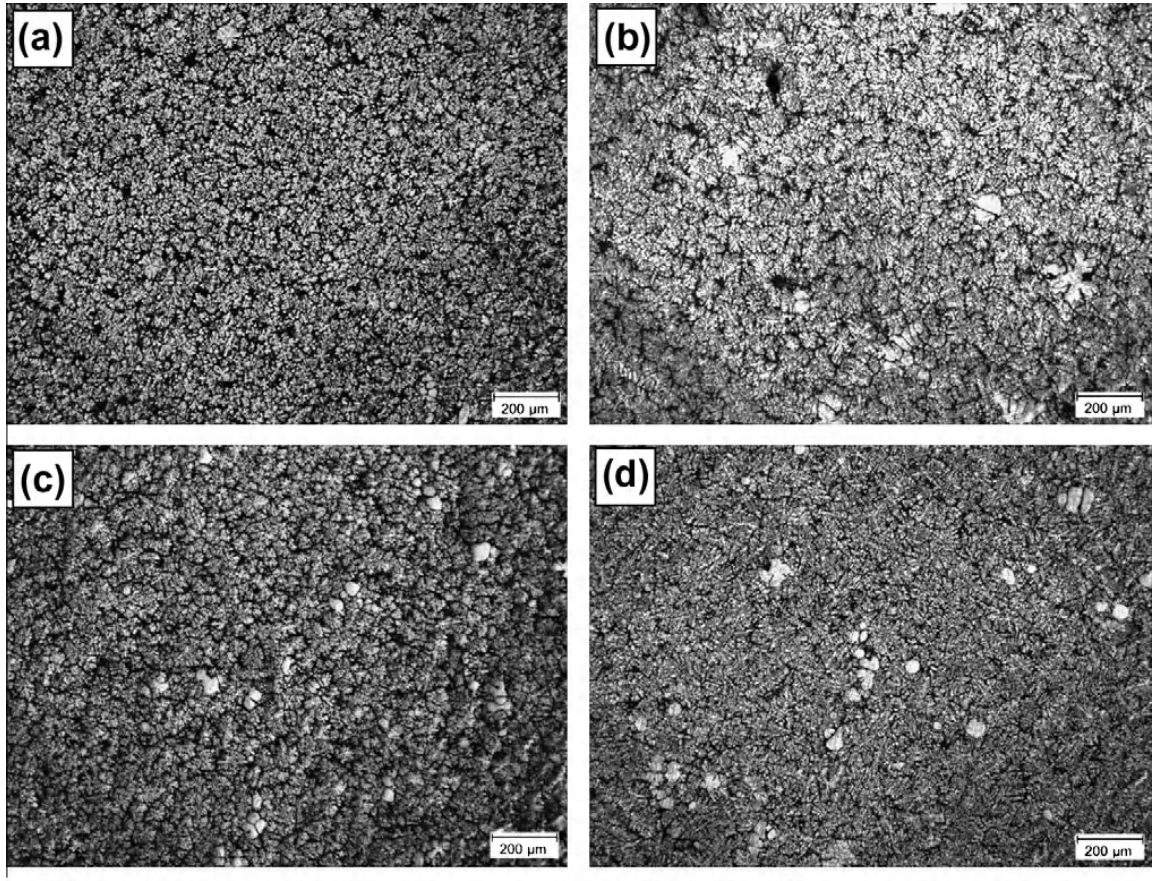
Warm Milk

Slurry

Semi-solid

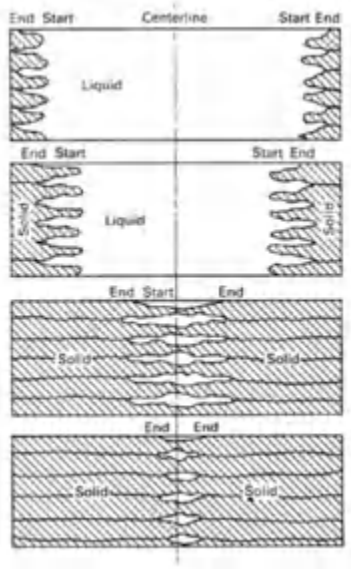
GISS: Superheated Slurry

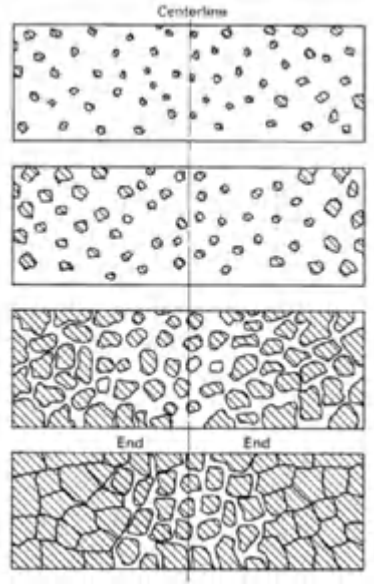
Even a small fraction of solid nuclei exist in superheated liquid has a big impact.



Viscosity Control

Reduction of Shrinkage Porosity



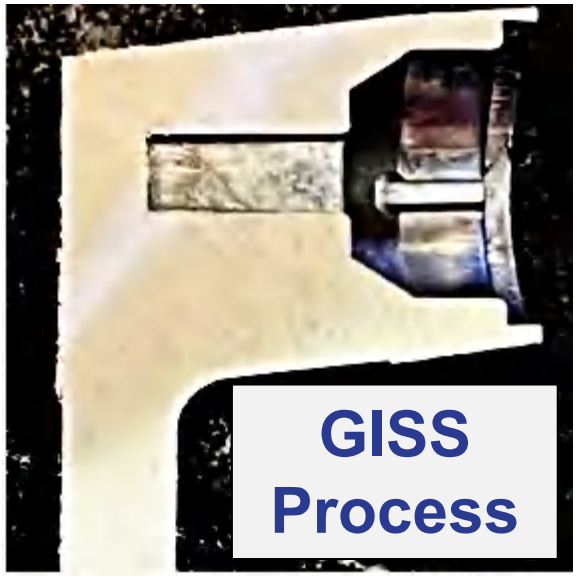


Reduction of Shrinkage Porosity

Effect of Solid Fraction

Same die casting parameters

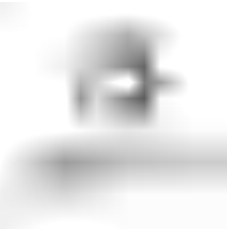
Solid Fraction Level 1



Solid Fraction Level 2

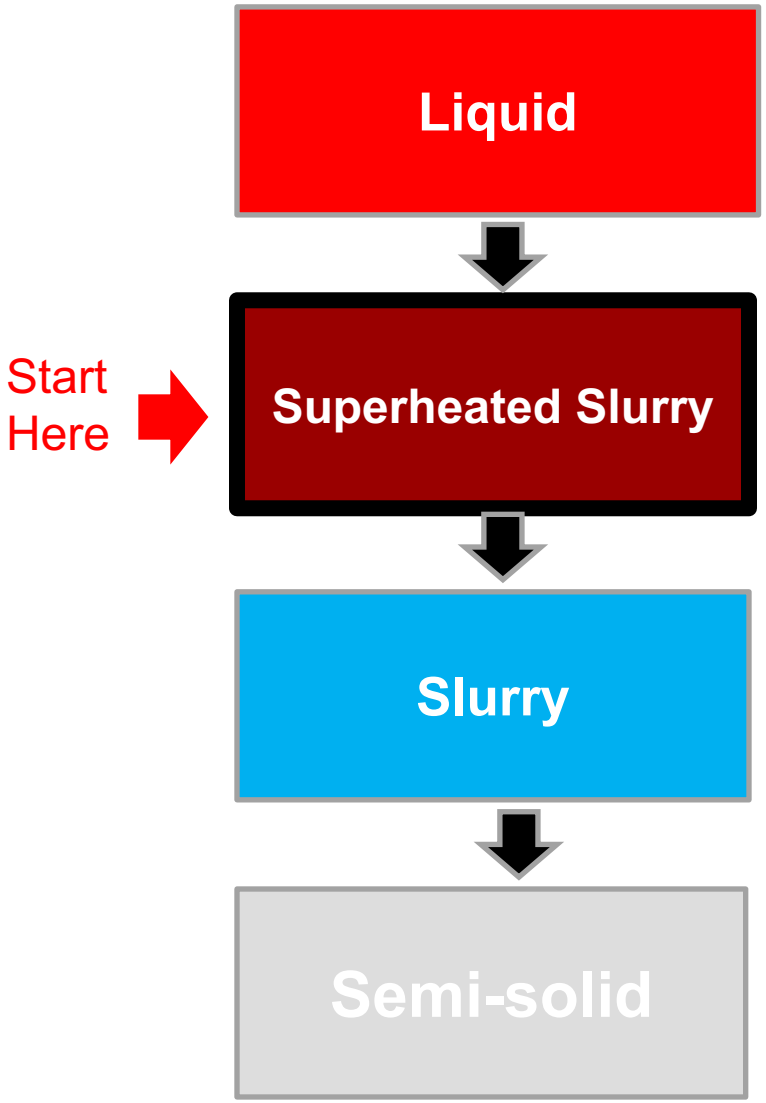
Solid Fraction Level 3

Pain Points Solved

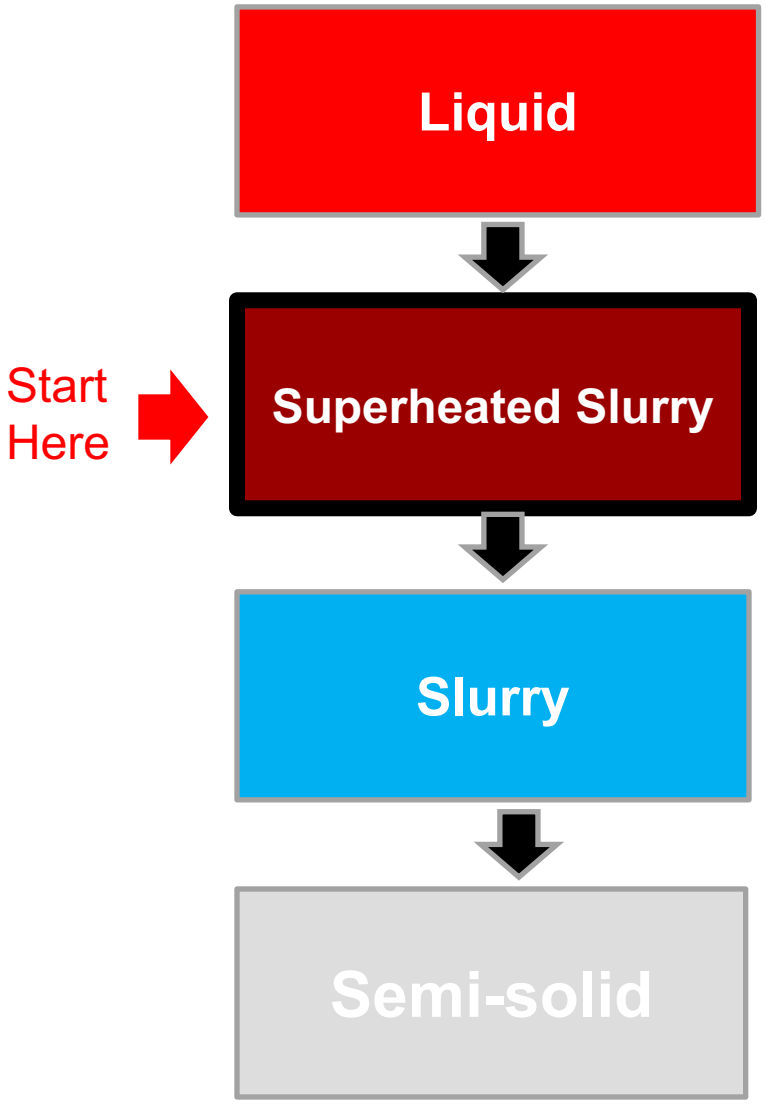


Cannot simply change the alloy	***Higher heat content allows better fluidity for very thin sections***
Cannot simply modify the HPDC machine	***No need to modify the die casting machine and process***
Cannot simply modify the die design	***No need to modify the die design***
	Wider range of processing window and solid fraction
	Any metals and alloys may be used (Al, Sn, Mg, Zn, Cu, Ag, Pt)

Nature of GISS Slurry



Nature of GISS Slurry



GISS for High Solid Fraction SSM Slugs

GISS Unit – Add-on Product

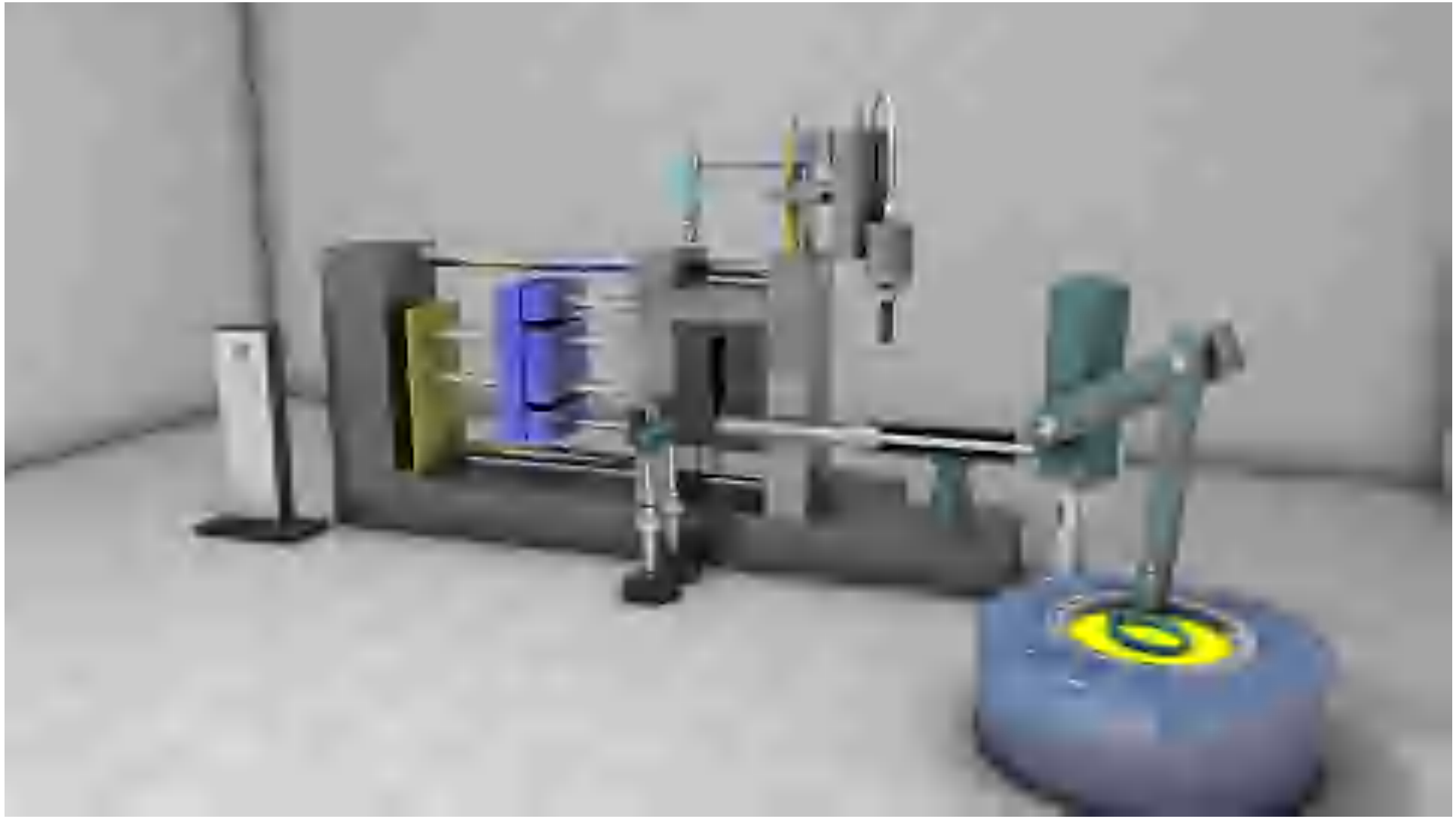
GISS Technology

GISS Control Unit

GISS Probe Unit

"GISS Unit is for process improvement, not for process change."

GISS Die Casting Process



KEY BENEFITS

Porosity Reject Reduction

Cycle Time Reduction

Die Life Extension

Energy Saving

Reduction in HPDC Machine Size

Porosity Reduction

ADC12

Liquid Die Casting

GISS Die Casting

Porosity Reduction

AC4C (A356)

Liquid Die Casting

GISS Die Casting

Porosity Reduction

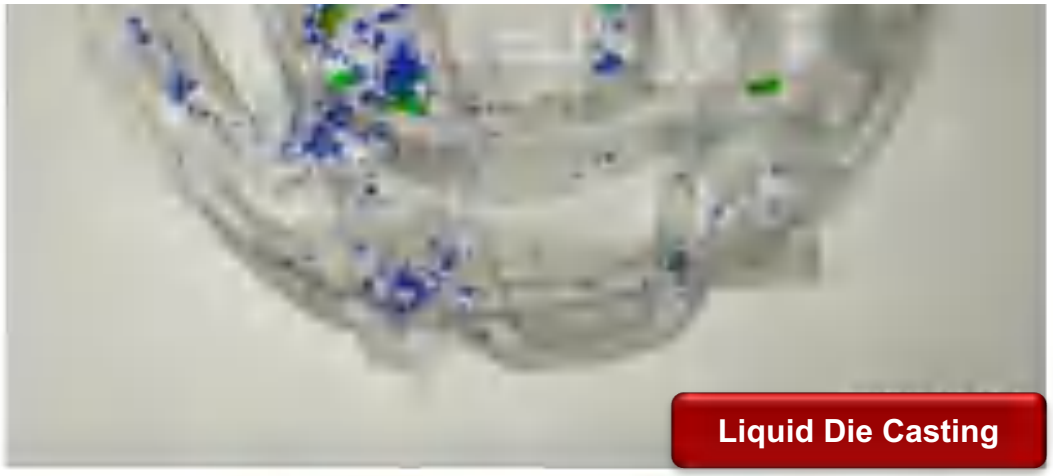
ADC14 (17%Si)

Liquid Die Casting

GISS Die Casting

Porosity Reduction

After Optimization



Porosity% 0.17%

Max Porosity 11.95mm

Porosity% 0.06%

Max Porosity 8.77mm

Cycle Time Reduction

Productivity Increase

1600-T HPDC machine

Cycle Time Reduction:

105 sec -> 85 sec (19%)

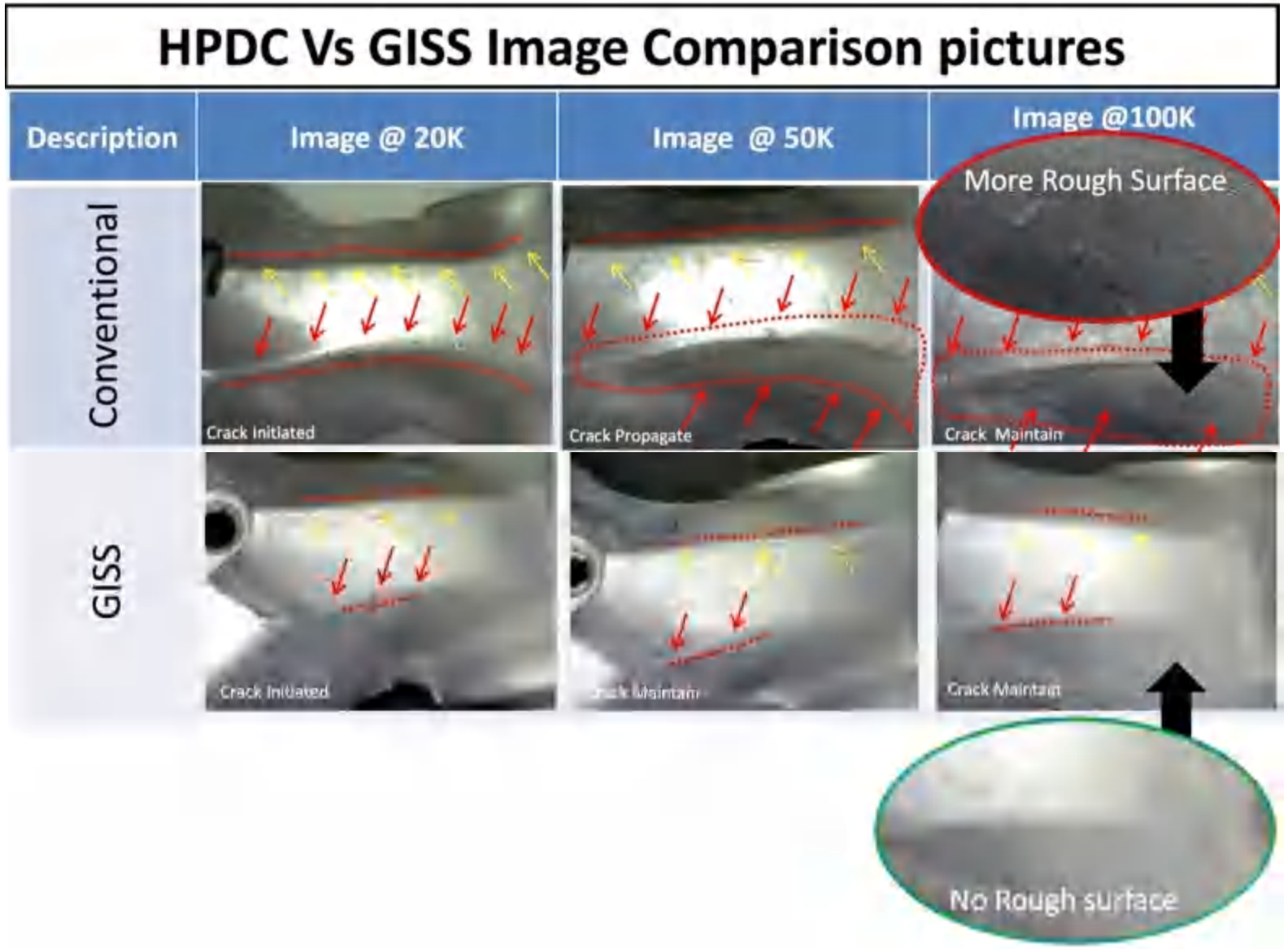
Die Life Extension

Conventional Die Casting

GISS Die Casting

More Than Double the Die Life

Case Study: Bicycle Manufacturer

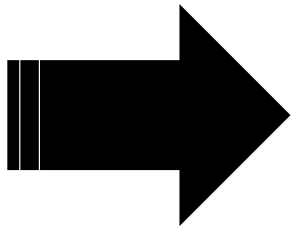


Die Life Extension

Machine Size	Alloy	HPDC Die Life (shot)	GISS Die Life (shot)
500-T	Al-2Mg-Mn	< 70,000	~ 300,000
900-T	ADC12	~ 100,000	~ 400,000
2,500-T	ADC12	~ 100,000	~ 300,000

Energy Saving

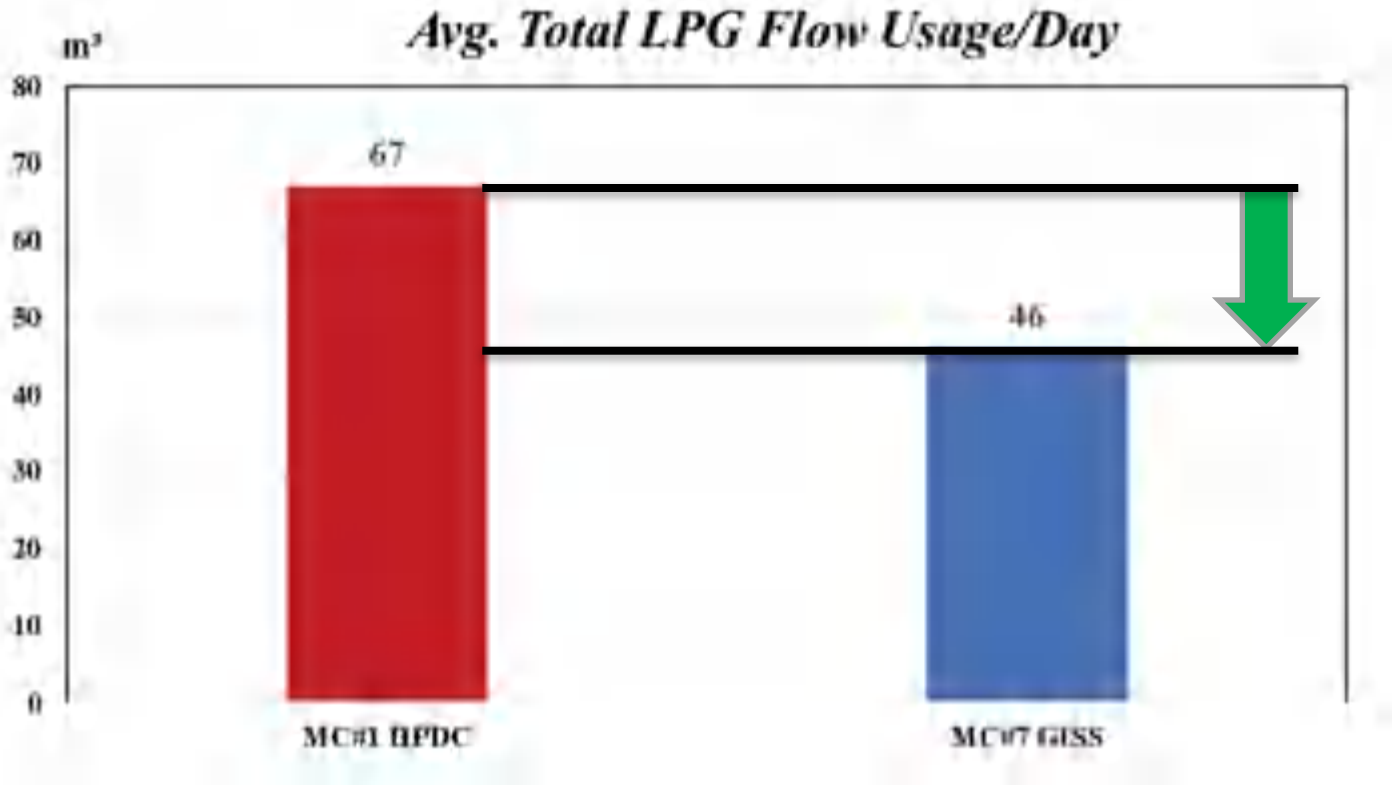
Holding Furnace Temperature:
680 C to 620 C



15-30%
Energy Saving

Energy Saving

Furnace	M/C	Shot weight (Kg.)	Part Name	Holding °C
MC#1 HPDC	350T	1.15	3414183	660
MC#7 GISS	350T	1.14	FD4	630



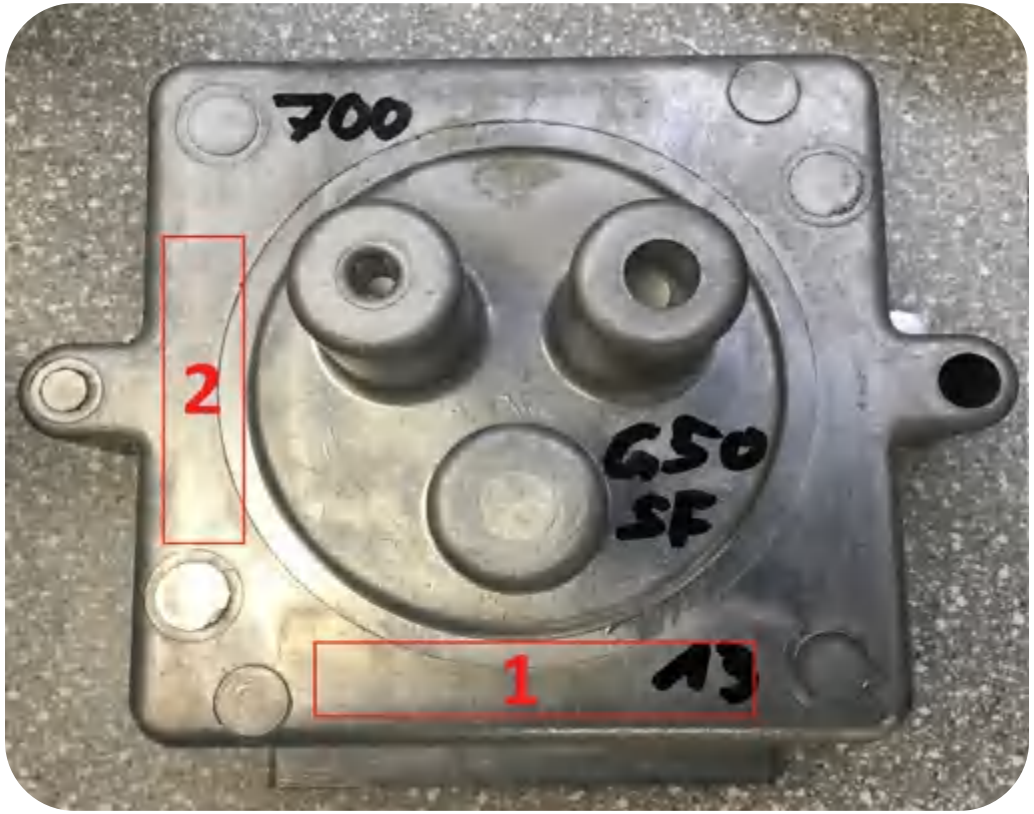
Saving ~ 21 m3/day (~31%)

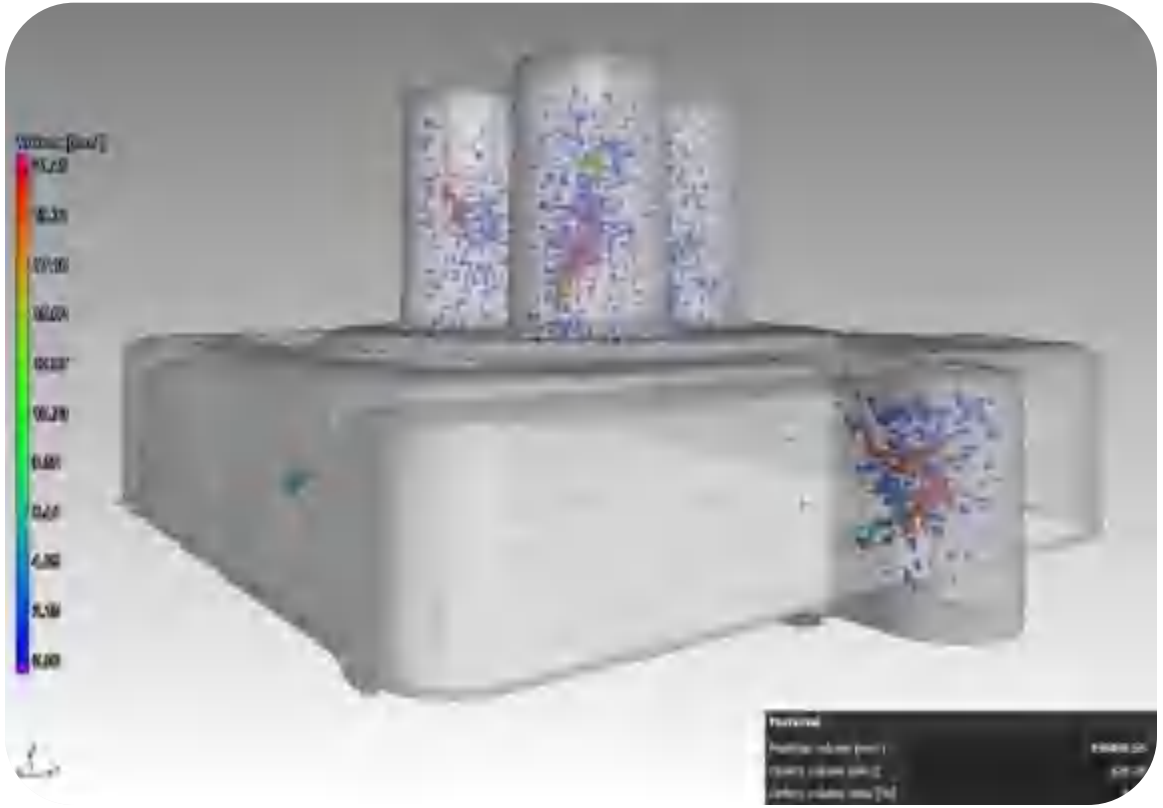
Reduction of Die Casting Machine Size Needed

GISS Technology Testing on Bühler Evolution 34

Reduction of Die Casting Machine Size Needed

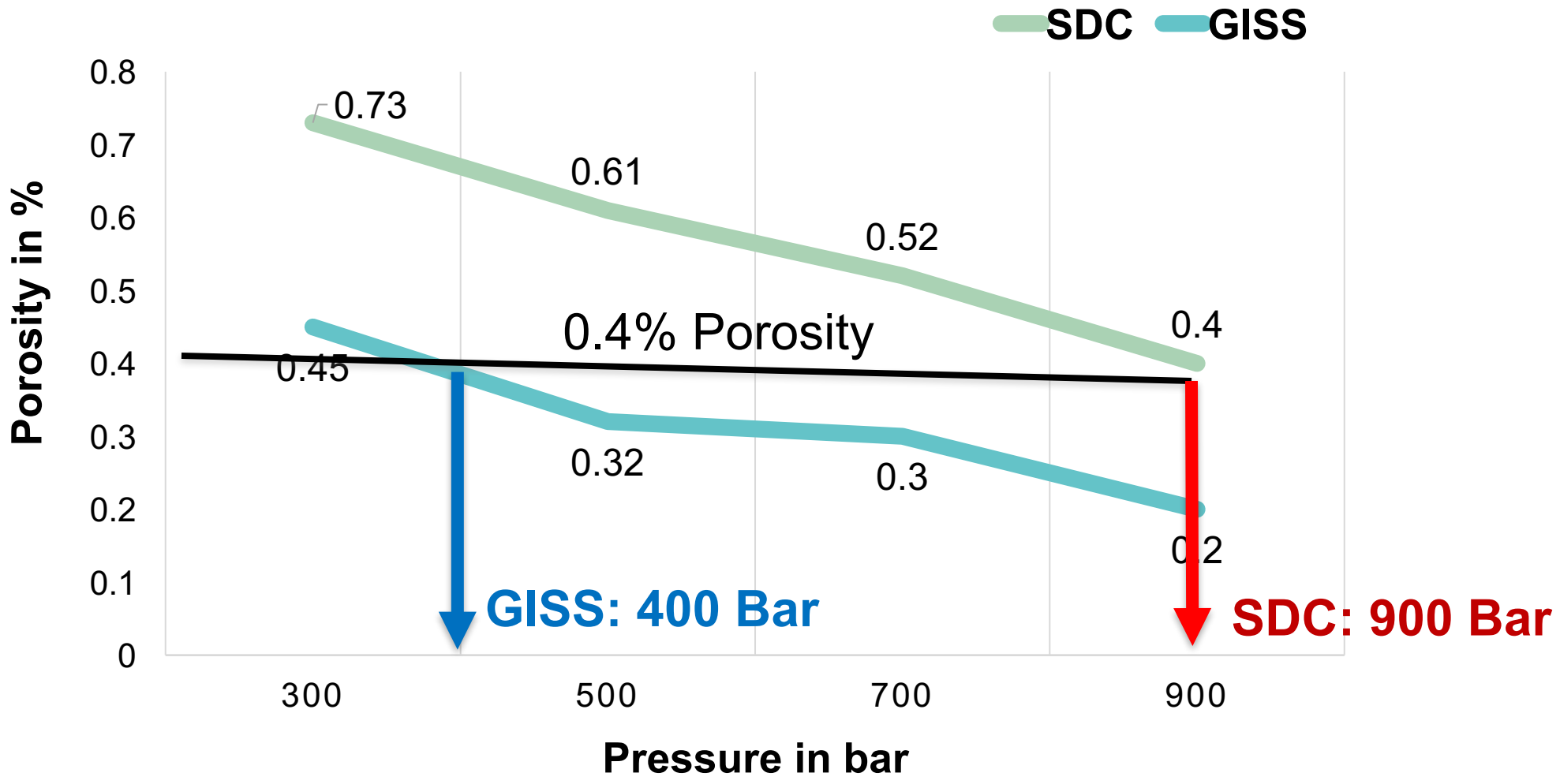
Test: GISS Technology vs Standard Die Casting



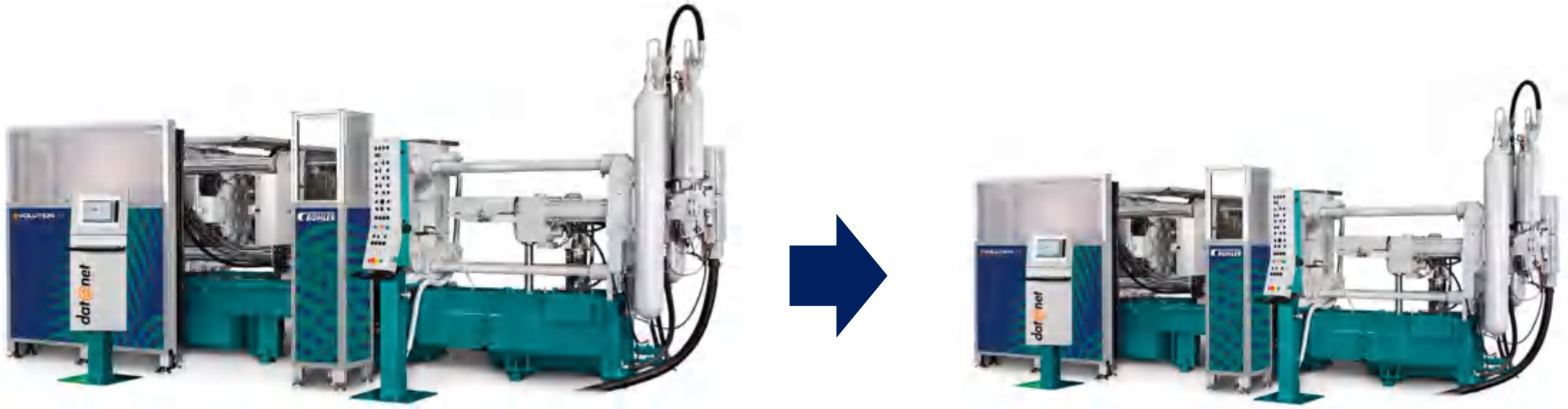


Reduction of Die Casting Machine Size Needed

Pressure Porosity Diagram of 226 Alloy



Reduction of Die Casting Machine Size Needed



2500T to **1650T**

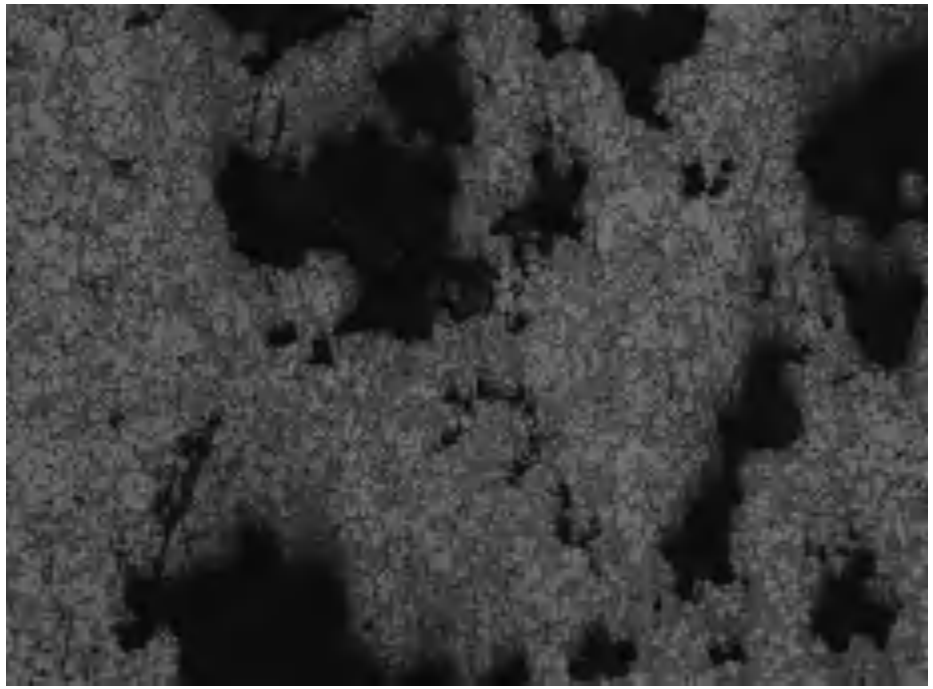
1250T to **900T**

Auto Applications: Compressor Part

Problem (leak sensitive compressor part)

Thick mass area in the part which is leak sensitive

Microstructure at the leaked location



CT analysis

Inference: Connected micro-porosity due to shrinkage is the root cause for the leak

Auto Applications: Solution through GISS

Before improvement, CT(HPDC)

After improvement CT(GISS)

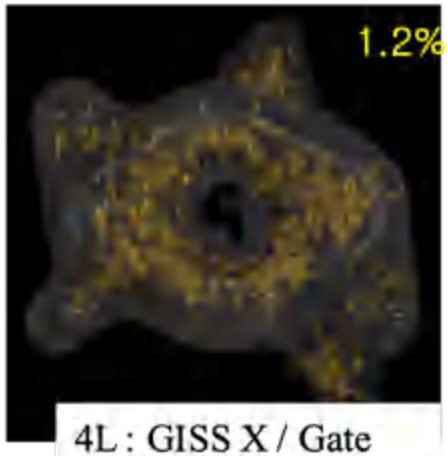
Before improvement

After improvement

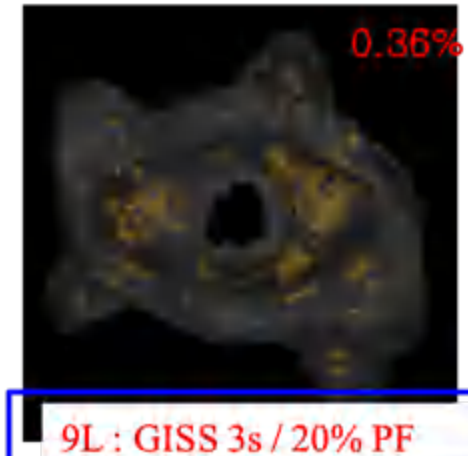
■ 내부결함 비교(CT분석)

- GISS /pre-filled 조건별 GISS 공정 조건 최적화
- 평가결과 : 9L(GISS 3s / 20% PF)

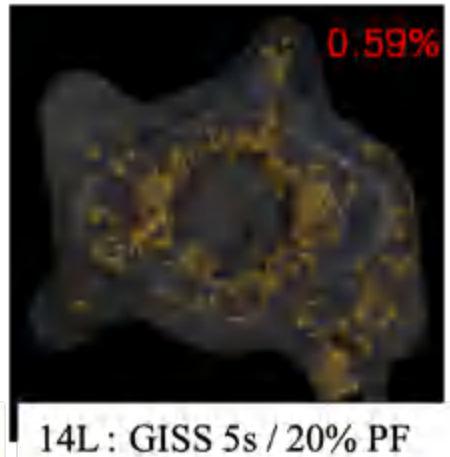
HYUNDAI MOTOR GROUP



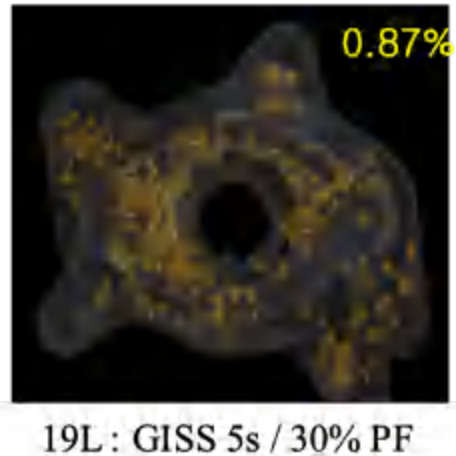
4L : GISS X / Gate



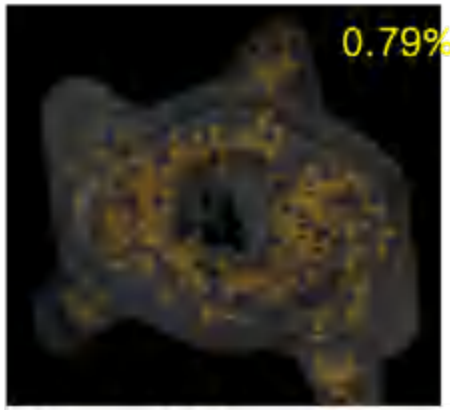
9L : GISS 3s / 20% PF



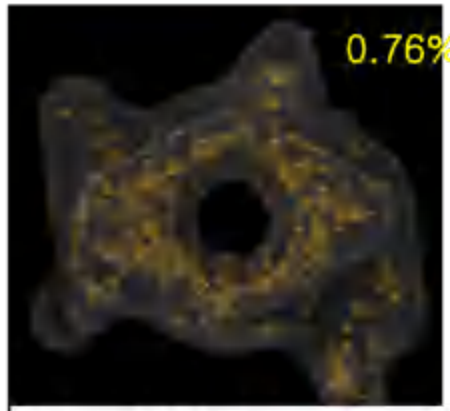
14L : GISS 5s / 20% PF



19L : GISS 5s / 30% PF

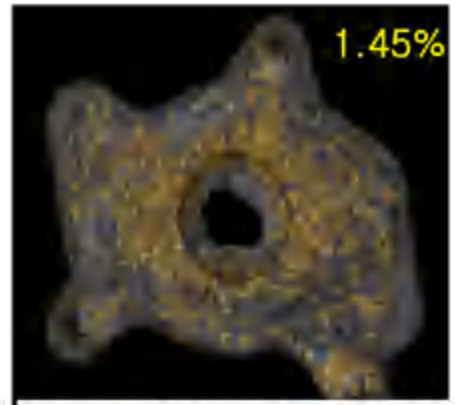


24L : GISS 5s / 50% PF



29L : GISS 7s / 50% PF

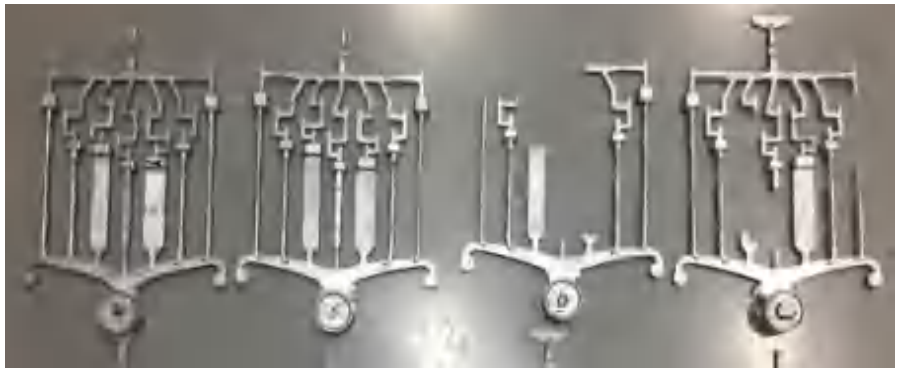
34L : GISS 7s / 50% PF



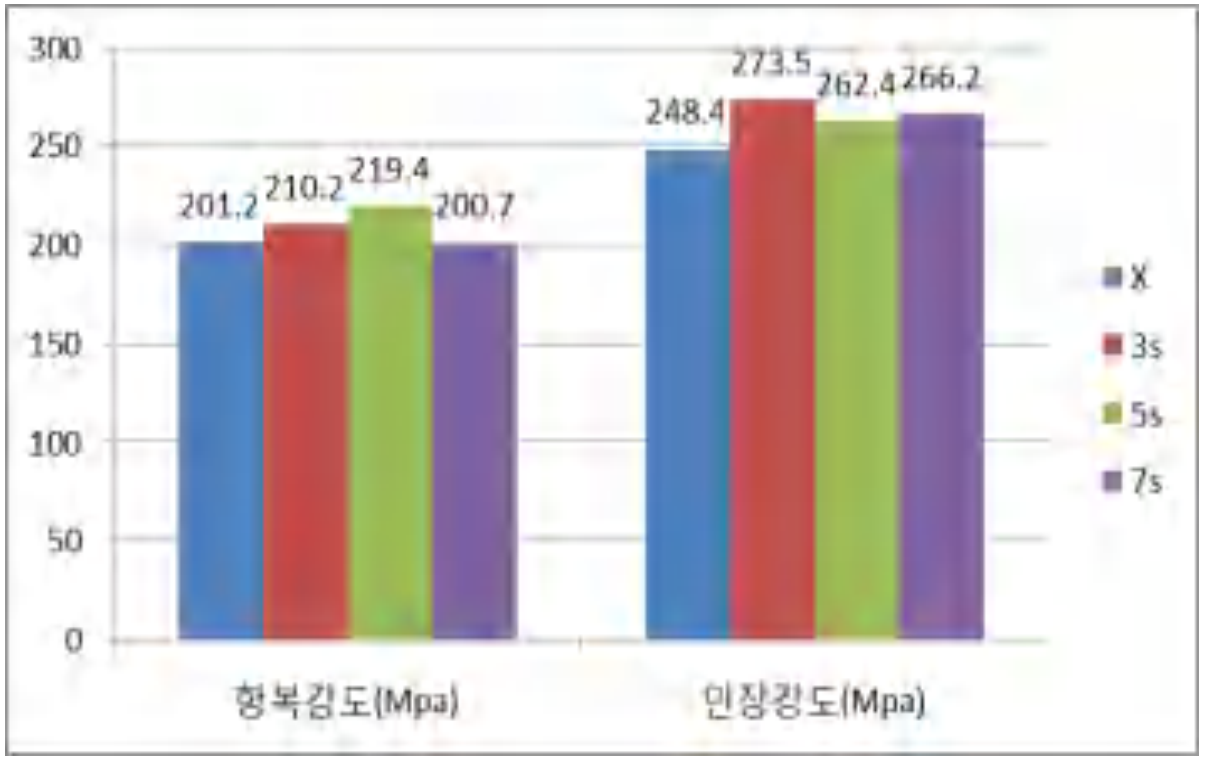
37L : GISS X / 30% PF

수축결함 비교(635℃)
(상: GISS X, 하: GISS 5s)

Property – ADC12-F

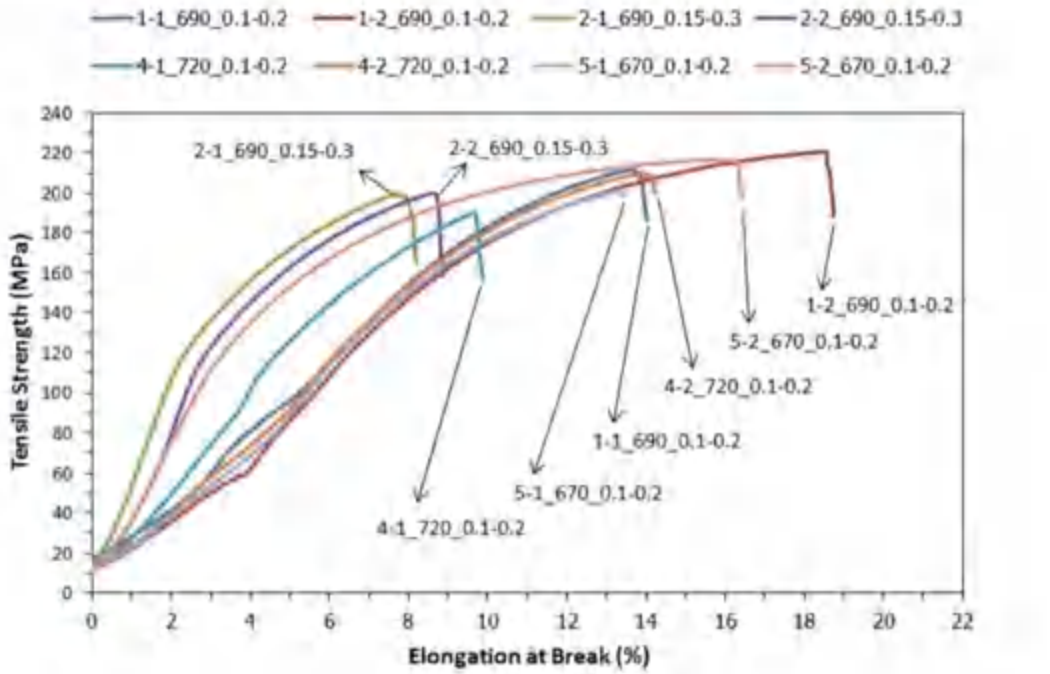


HYUNDAI
MOTOR GROUP

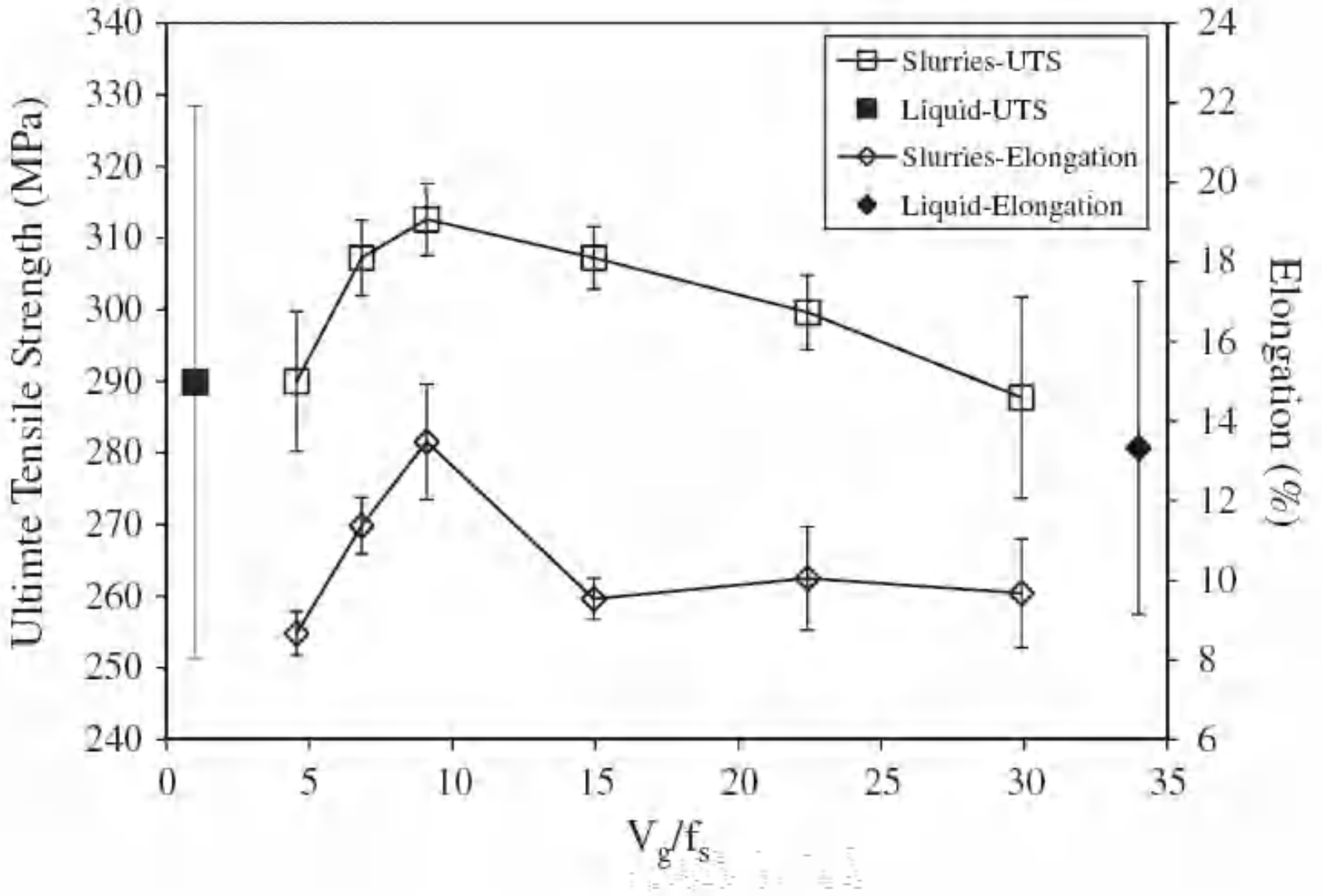


Property – AC4C-F

Samples	Yield Strength, YS (MPa)	Ultimate Tensile Strength, UTS (MPa)	Elongation at Break (%)
1) 1-1_690_0.1-0.2	180.0	211.8	14.0
2) 1-2_690_0.1-0.2	172.0	220.8	18.7
3) 2-1_690_0.15-0.3	130.0	199.7	8.2
4) 2-2_690_0.15-0.3	132.0	200.1	8.9
5) 4-1_720_0.1-0.2	152.0	196.5	9.9
6) 4-2_720_0.1-0.2	164.0	218.2	14.2
7) 5-1_670_0.1-0.2	158.0	201.0	13.5
8) 5-2_670_0.1-0.2	136.0	216.8	16.4



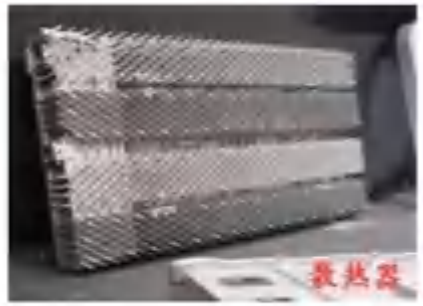
Property – A356-T6

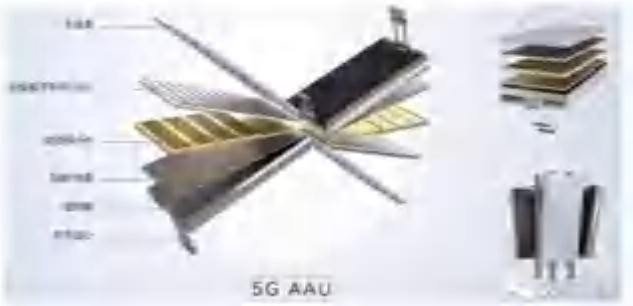


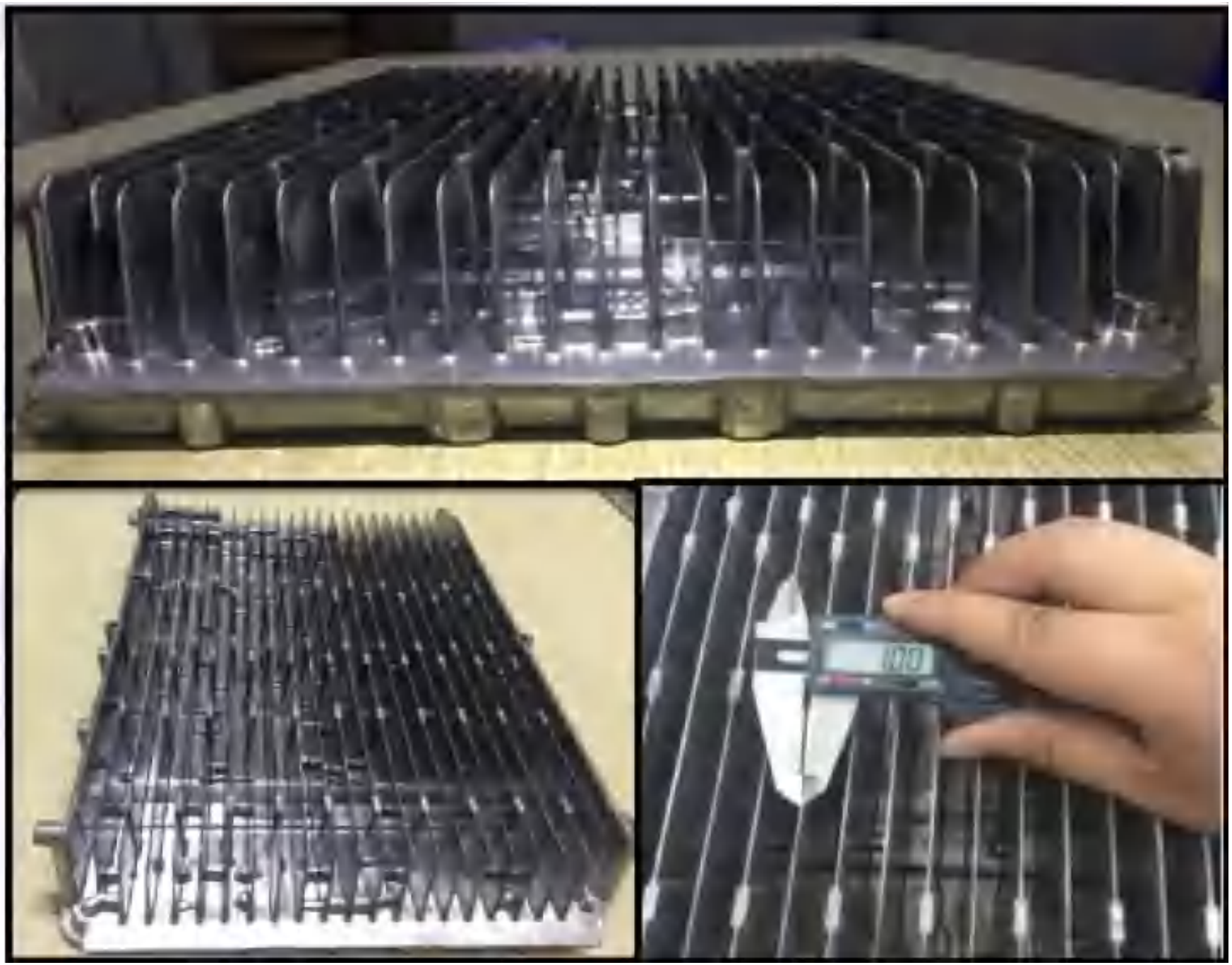
GISS Applications in Electronic Industry

5G Radiator and Filter Products

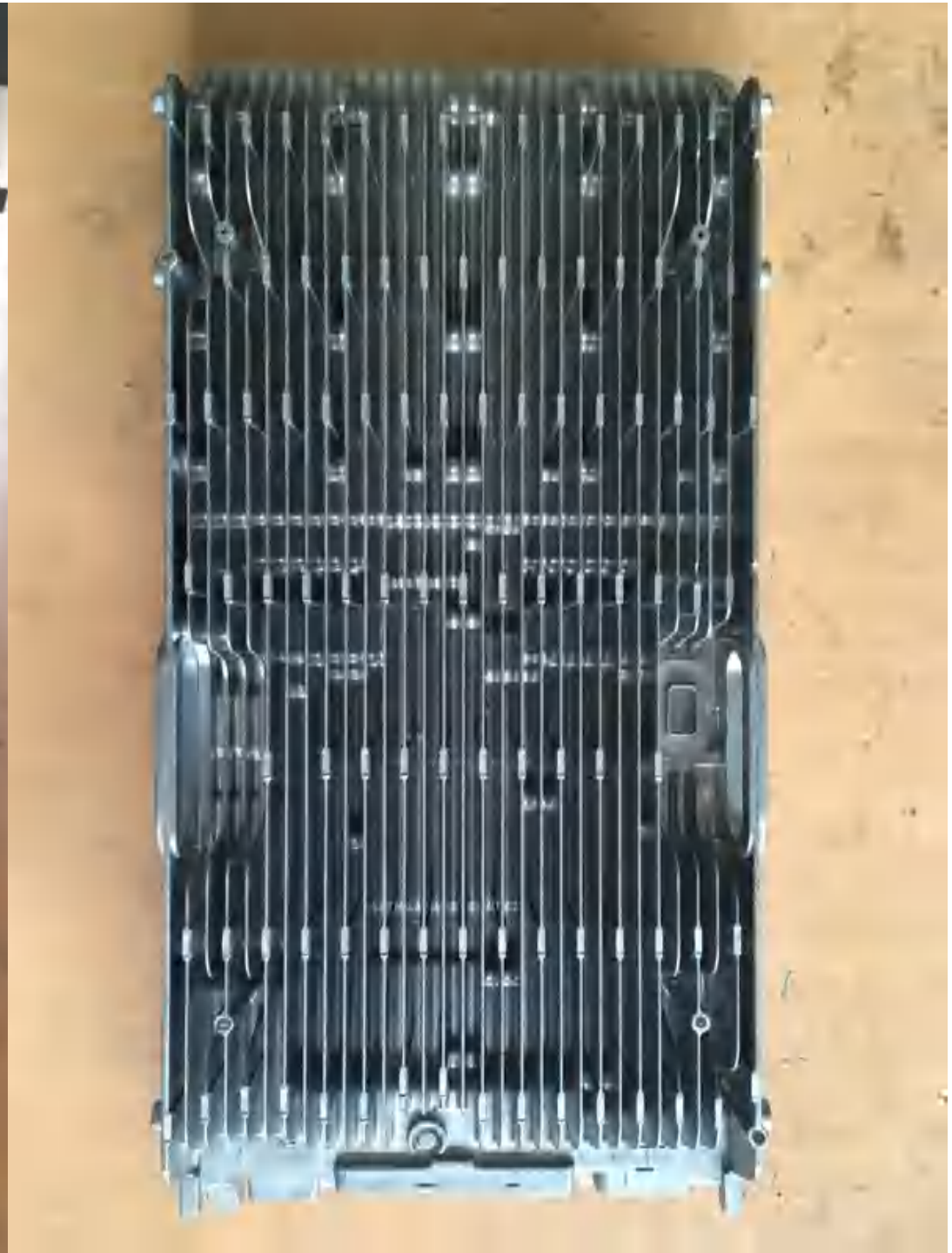
- High thermal conductivity alloy
- Less soldering and erosion at gate
- Reduce product distortion and flatness
- Reduce aging heat treatment time
- High surface quality requirement
- Longer die life
- Less flash








638x370x131mm




400x350x77x1.3mm, 9.05kg


585x350x131x1.5mm

Cost vs Benefits

Current Commercial Units:

0.1 kg to **>100 kg**

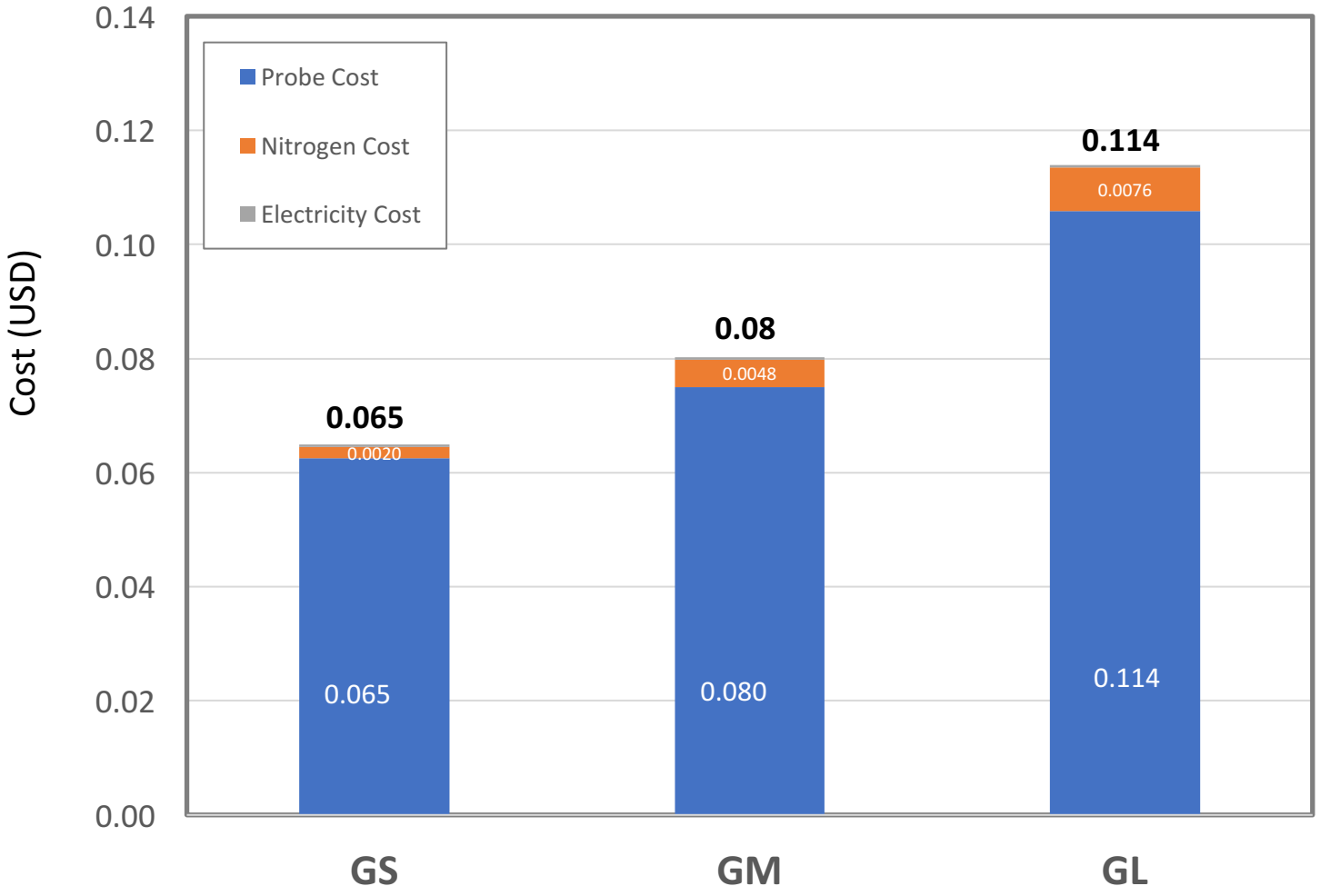
Operating of GISS

GISS Unit Model	Probe Cost					Nitrogen Gas Cost					Electricity Cost			
	Probe Price (USD/Unit	Probe Life (sec.)	Probe Cost (USD/S	Probe Cost (USD/Shot)		Gas Nitrogen Price 6,000 Liter	Number of Shots/Cylinder		Nitrogen Gas Usage Cost		GISS Unit Power Usage	GISS Unit Power Usage per	Electricity Cost (USD/kW-	Electricit y Cost (USD/sh
				3 Sec.	5 Sec.		3 Sec.	5 Sec.	3 Sec.	5 Sec.				
GS	1,150	100,000	0.01	0.03	0.06	6.18	3,744	3,124	0.0017	0.0020	200	0.003	0.13	0.0004
	1,350		0.01	0.04	0.07									
GM	1,500		0.02	0.05	0.08		1,756	1,275	0.0035	0.0048				
GL	1,850		0.02	0.06	0.09									
	2,100		0.02	0.06	0.11		1,093	810	0.0057	0.0076				
	2,400		0.02	0.07	0.12									

Note *: (1) Warranty Probe Life 100,000 Sec. (Shot x Slurry Time)*

(2) Gas Nitrogen 6,000 Liter price of Thailand = 220 bath/Cylinder = 6.18 USD/Cylinder

Average GISS Operating Cost Per Shot @ 5 sec GISS



Cost Benefits of GISS

GISS Cost Model

Fill In

Part Name: __Housing__

General Information

Machine Size	2500	Ton
Shot Weight	15	kg
Part Weight	9	kg

No. of Parts to Deliver	250,000	Parts/yr
Working Day	300	days/yr
Working Hours	22	hrs/day

Current Process Conditions

Die Time	4	sec
Spray Time	2	sec
Total Cycle Time	95	sec
Holding Temperature	660	deg C
Reject Rate	10	%

GISS New Conditions

Die Time	3	sec
Spray Time	1	sec
Total Cycle Time	90	sec
Holding Temperature	620	deg C
Reject Rate	5	%

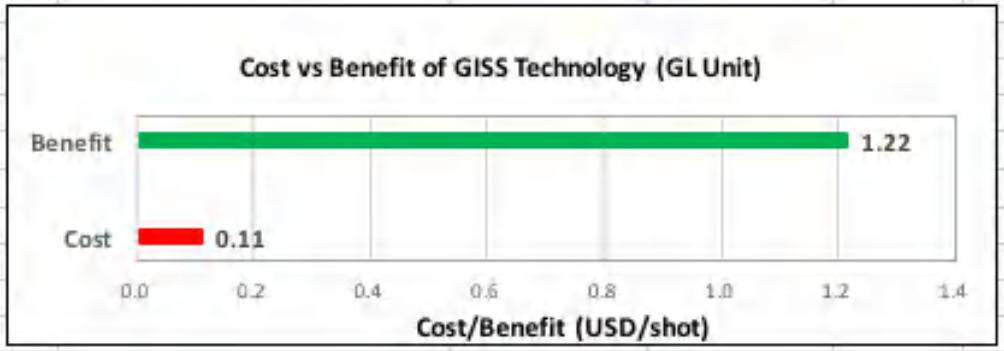
5.26	%	CT Reduction

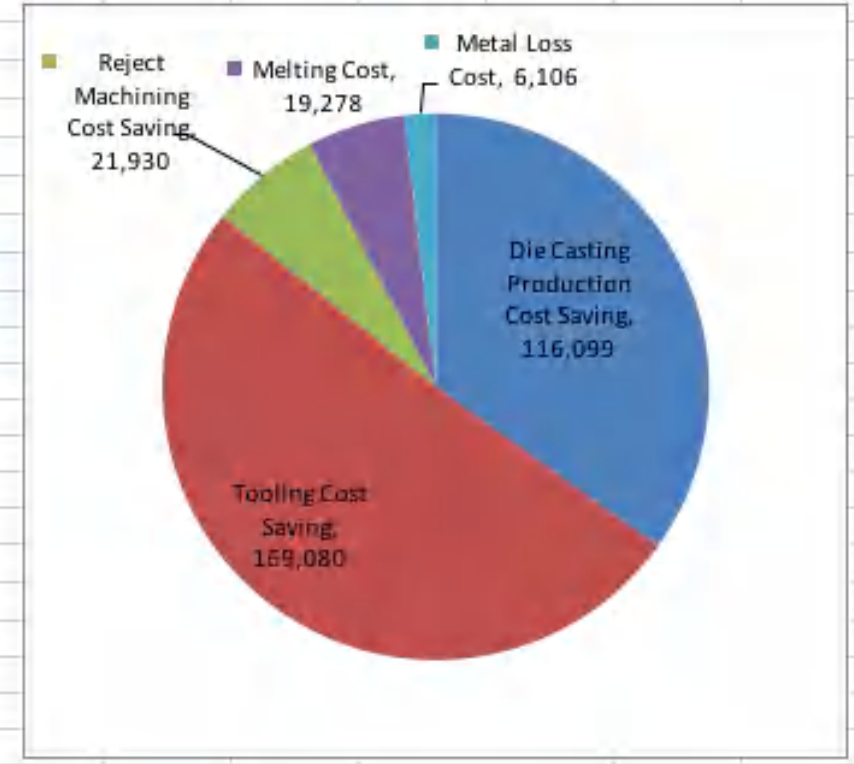
Cost Benefits of GISS

Total Cost Saving

Die Casting Production Cost Saving	116,099	USD/yr	0.4607	USD/shot
Tooling Cost Saving	169,080	USD/yr	0.6710	USD/shot
Reject Machining Cost Saving	21,930	USD/yr	0.0870	USD/shot
Melting Cost	19,278	USD/yr	0.0765	USD/shot
Metal Loss Cost	6,106	USD/yr	0.0242	USD/shot
Total Cost Saving of GISS Technology	307,109	USD/yr	1.3194	USD/shot

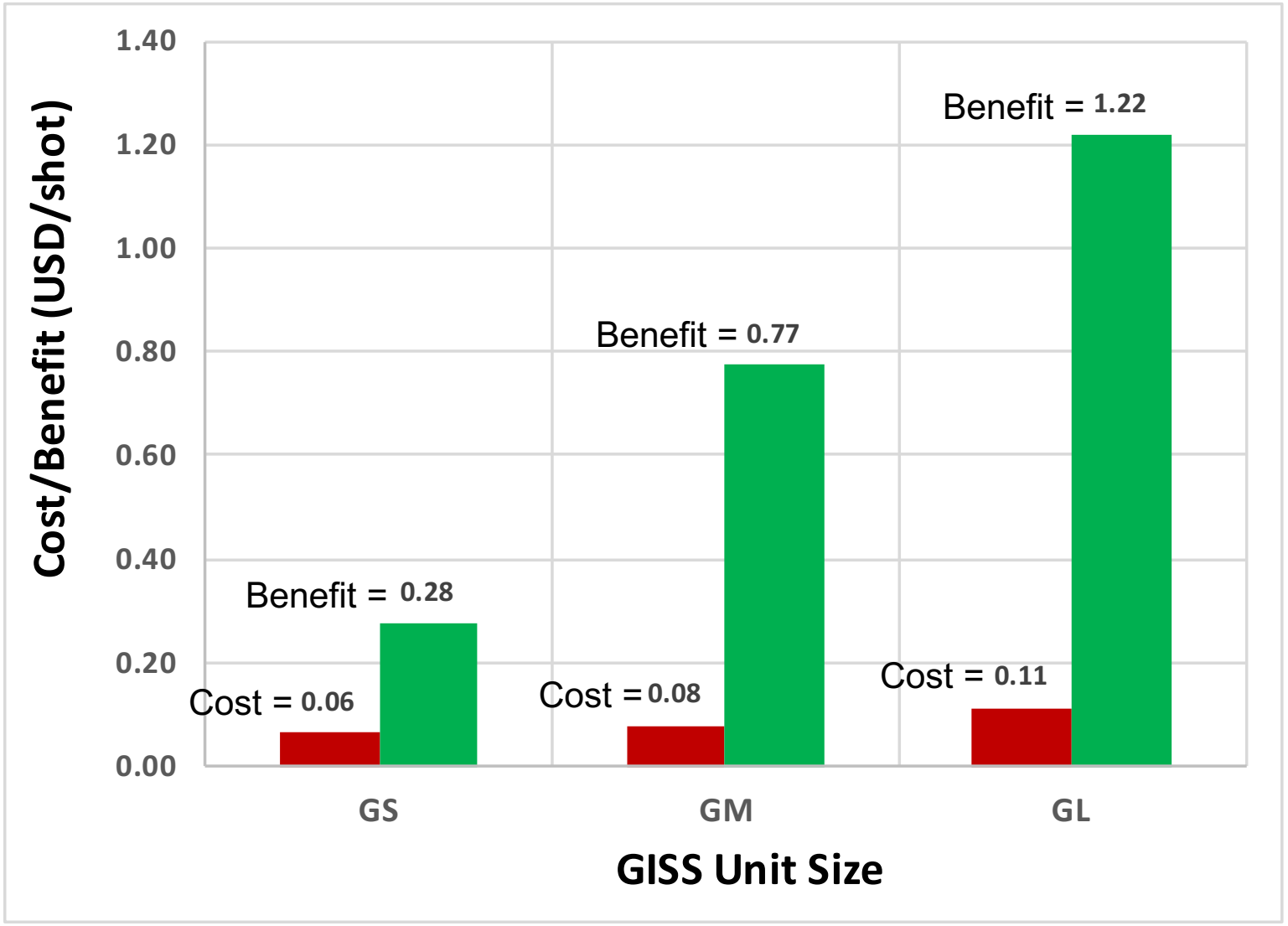
Cost of GISS Unit (GL Model)	165,000	USD/unit
Pay-back Period	6.4	Month





	Probe Cost	Nitrogen Cost	Electricity			
Cost	0.1058	0.0076	0.0004			0.1139
	Production	Die Life	Machining	Melting	Al Lost	
Benefit	0.4607	0.6710	0.0870	0.0765	0.0242	1.2187

Cost Benefits of GISS



(GL Unit)
Every Shot!

Profit = 1.1 USD
($330,000/Yr)

6 Months
Payback!

Current Number of GISS Units

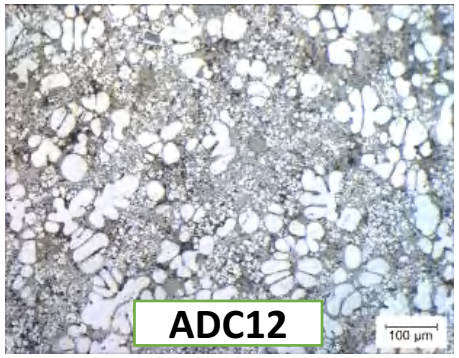
GISS Technology

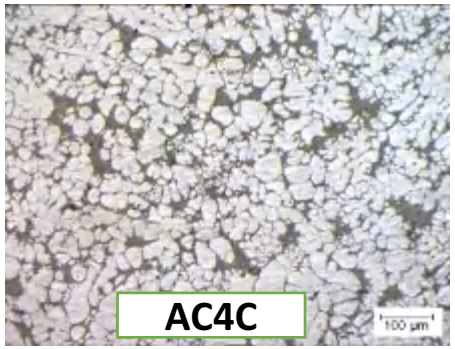
More than 160 GISS Units in 16 Countries

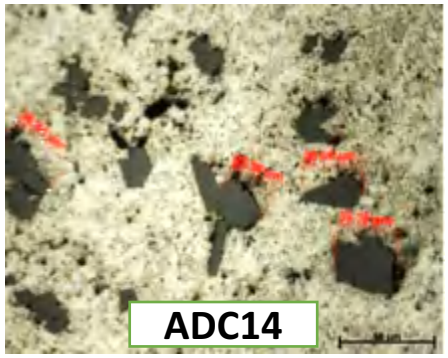
A company is using 19 GISS Units in Mass Production

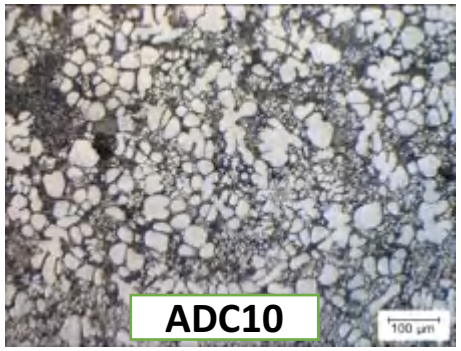
GISS Units

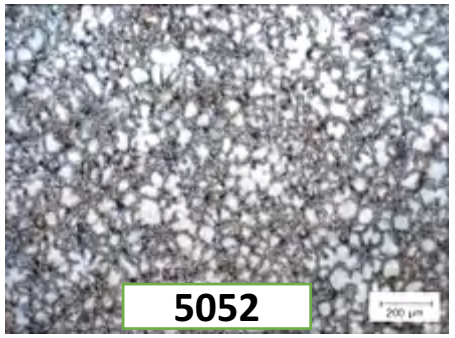
GISS can process any alloys

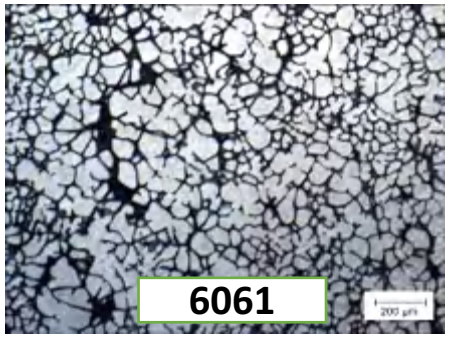


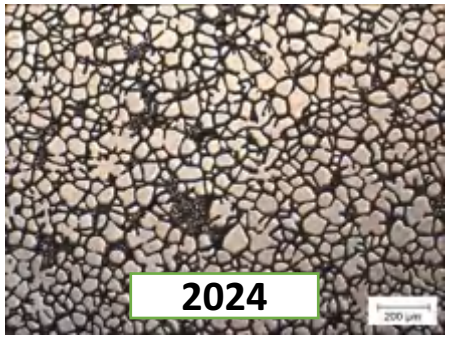


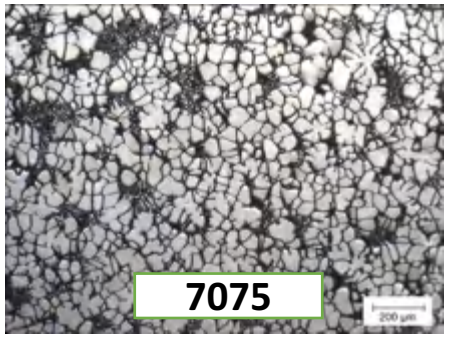


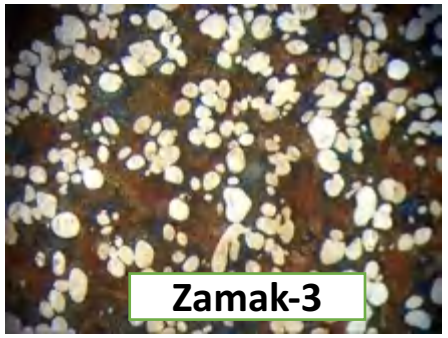












Smaller M/C Tonnage

Faster CT

Longer Die Life

Lower Energy

Less Shrinkage

Less Gas Porosity

Existing HPDC Process and Alloys

Behaviors & Benefits of Slurry

New Machine

New Alloys

Higher Conductivity

Higher Strength

Higher Ductility

Anodizable

Small M/C Tonnage

Small Foot Print

Cheaper Die

Longer Die Life

Multi-Cavity

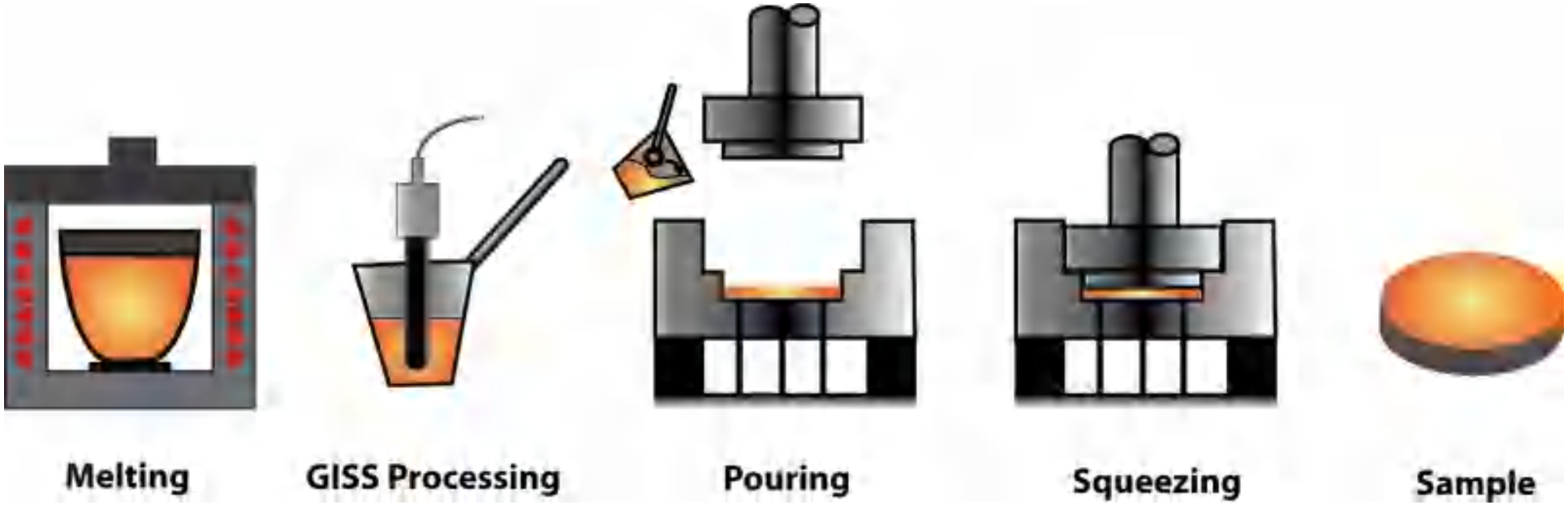
Symmetry

We are not just SSM or Rheocasting, we are Superheated Slurry Technology.

Other SSM or Rheocasting processes cannot process any metals and be used in any processes

GISS SLURRY FORGING (SF)

GISS Slurry Forging



Slurry Squeeze Casting Technique

"GISS Slurry Forging"

Small Clamping Pressure = Small Machine

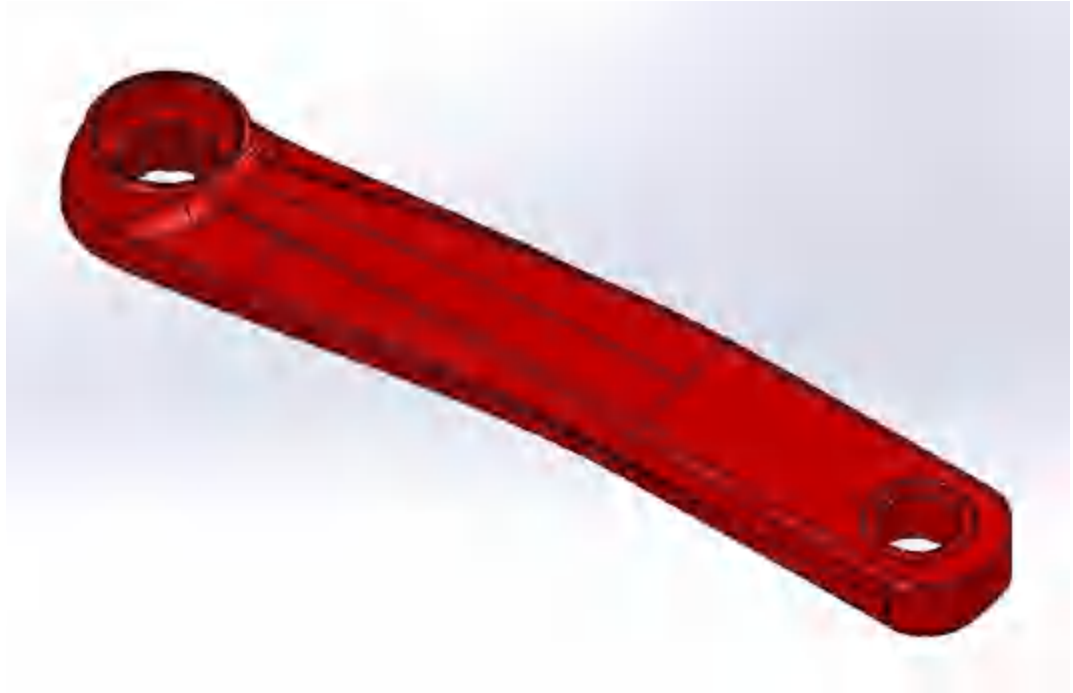
100-T Press

17-inch Wheel

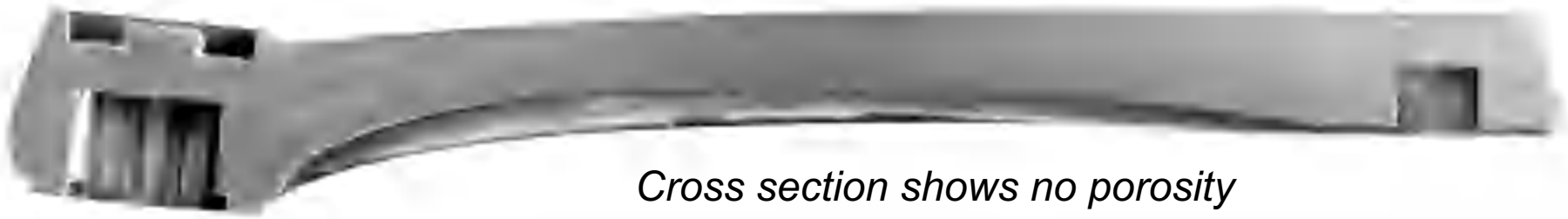
GISS Slurry Forging: Prototype 1

100-T Press

GCS for High Integrity Components



ADC12



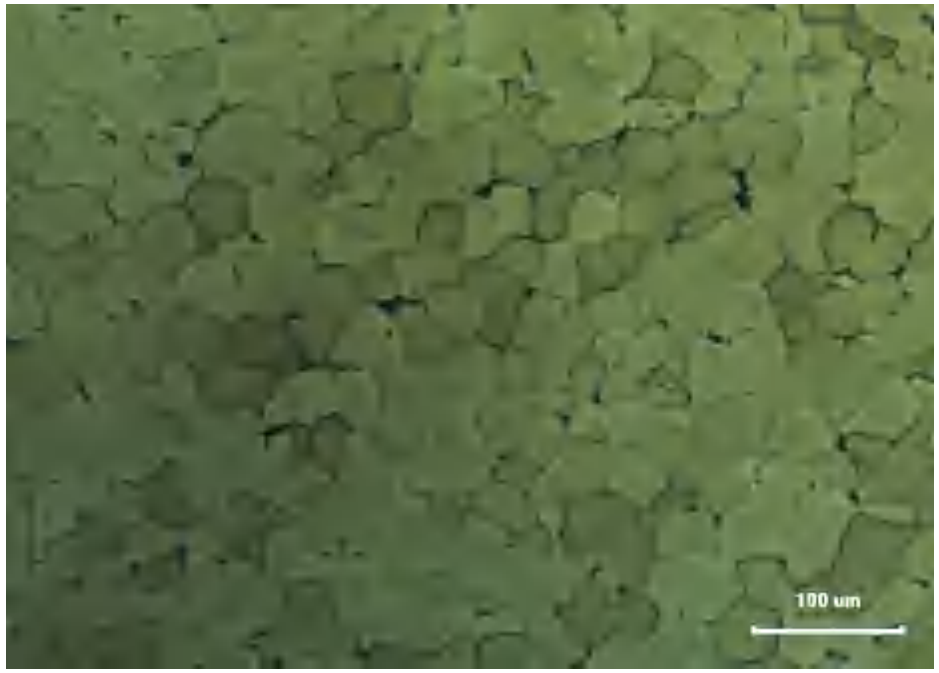
Cross section shows no porosity

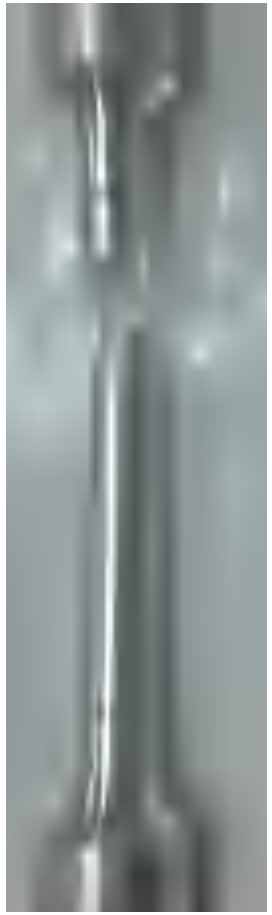
ADC12-T6

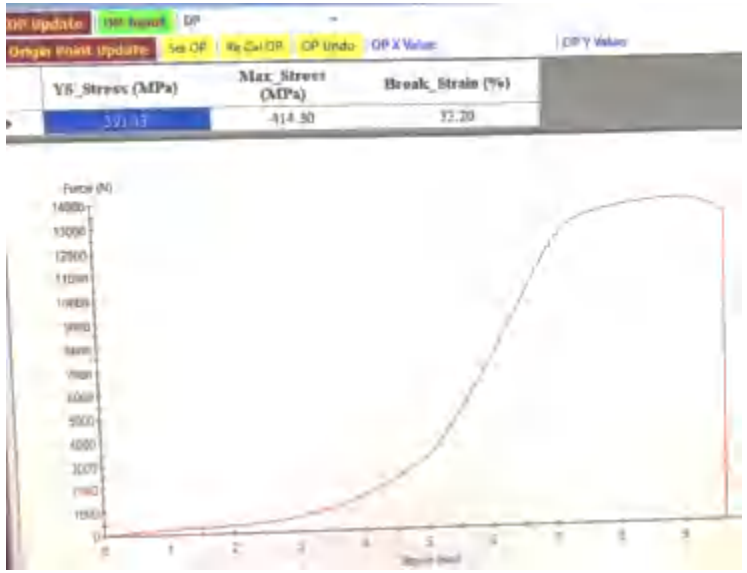
Anodized 6063-T6

Mechanical Properties

7075-T6 Mechanical Properties







UTS = 420-450 MPa

YS = 400-410 MPa

%Elong = 6-10%

Anodized Die Casting: Surface Quality Optimization

VRace

6061-T6
6063-T6
7075-T6

GISS VERTICAL SLURRY CASTING (VSC)

GISS VSC for Mass Production

Potential Benefits

Smaller Footprint Machine, Small Die

Required Less Clamping Force

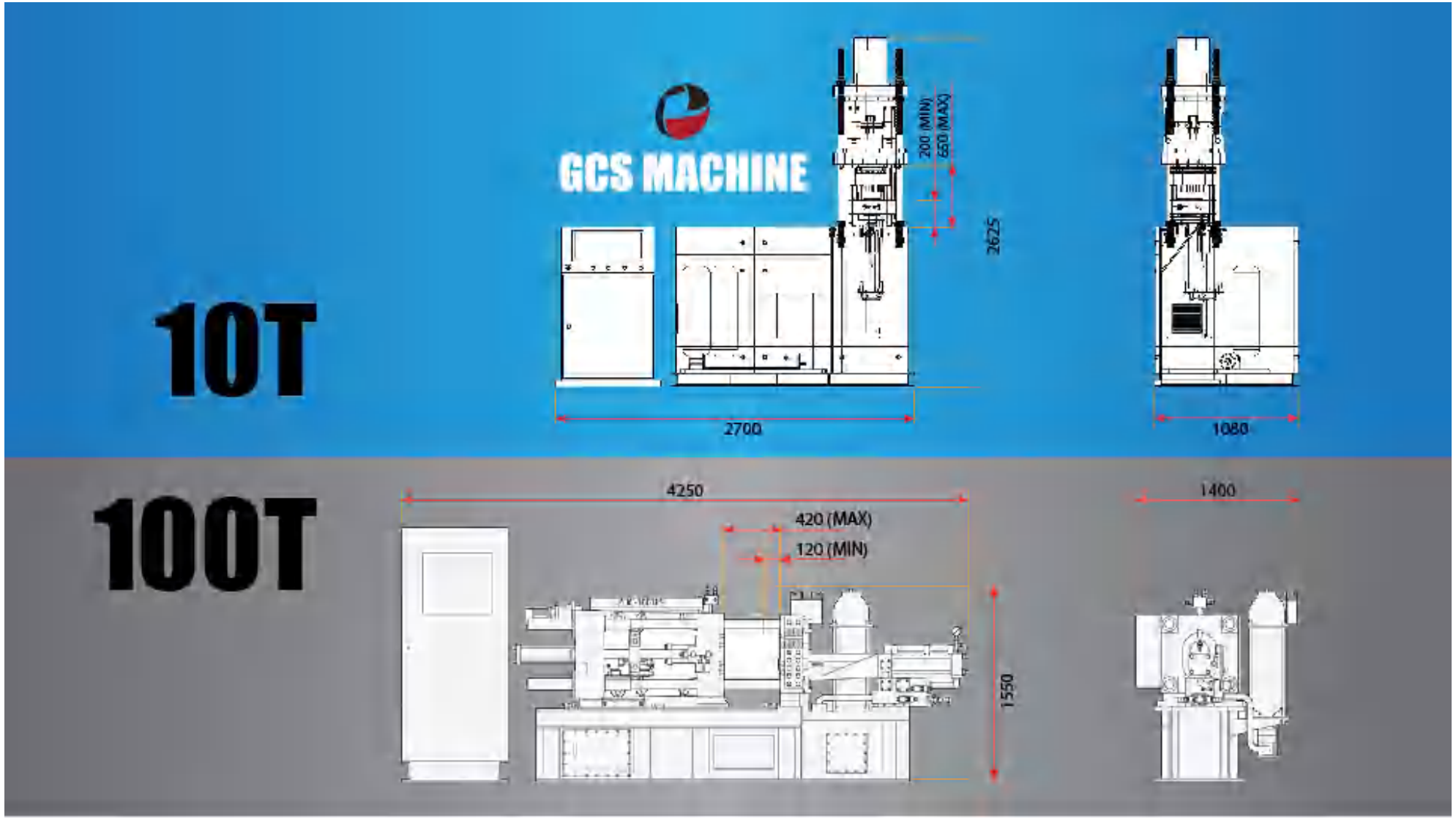
Uniform and Symmetric Flow for Multi-Cavity

Faster Cycle Time

Higher Casting Yield

Prototype 1

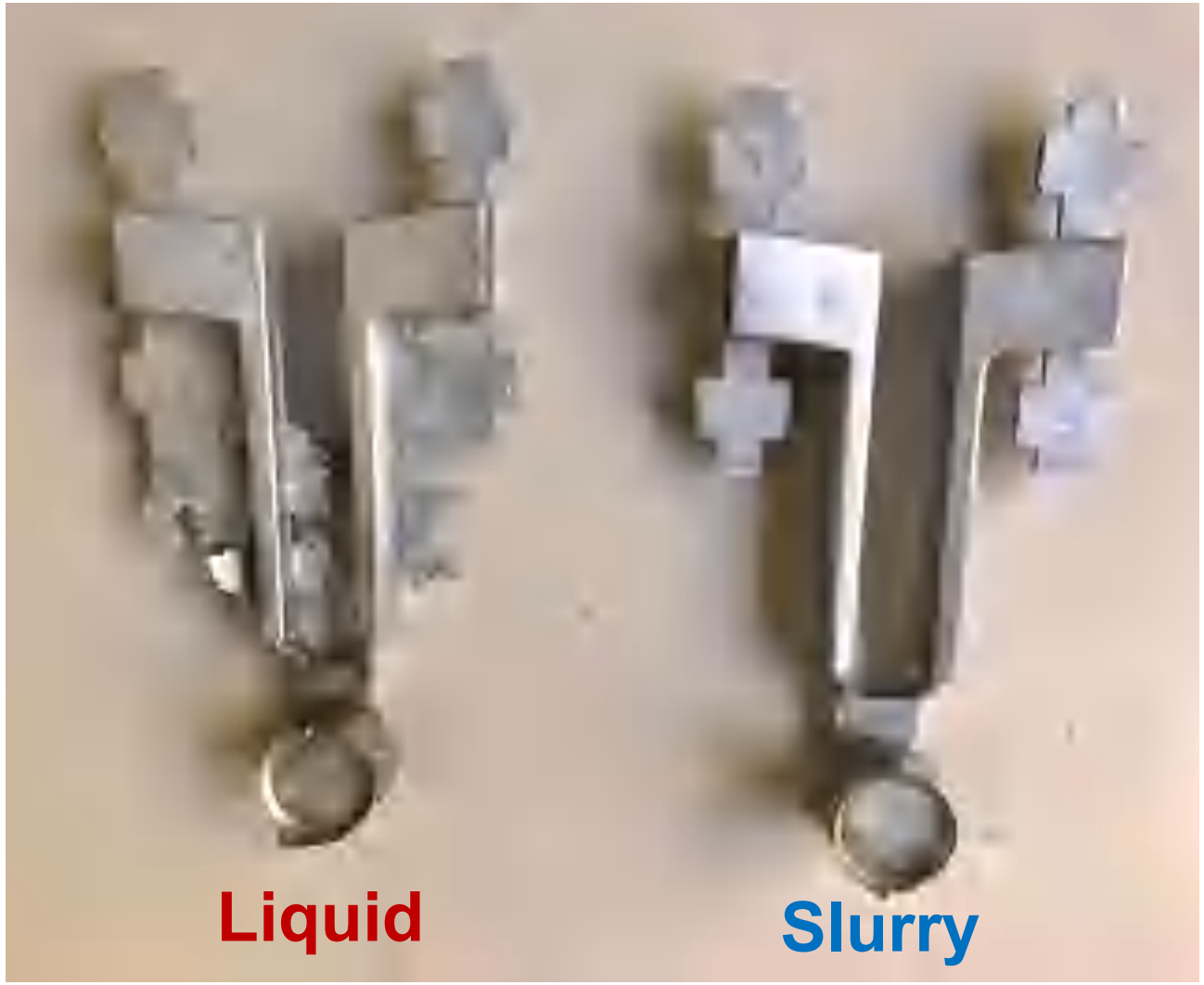
Prototype 1


GCS MACHINE
10T
200 (MIN)
650 (MAX)
2625
2700
1080
100T
4250
420 (MAX)
120 (MIN)
1400
1550

Prototype 1


Footprint Area
4250
2700
GCS MACHINE
Target Size
~ 1/3
10T
100T
1080
1400

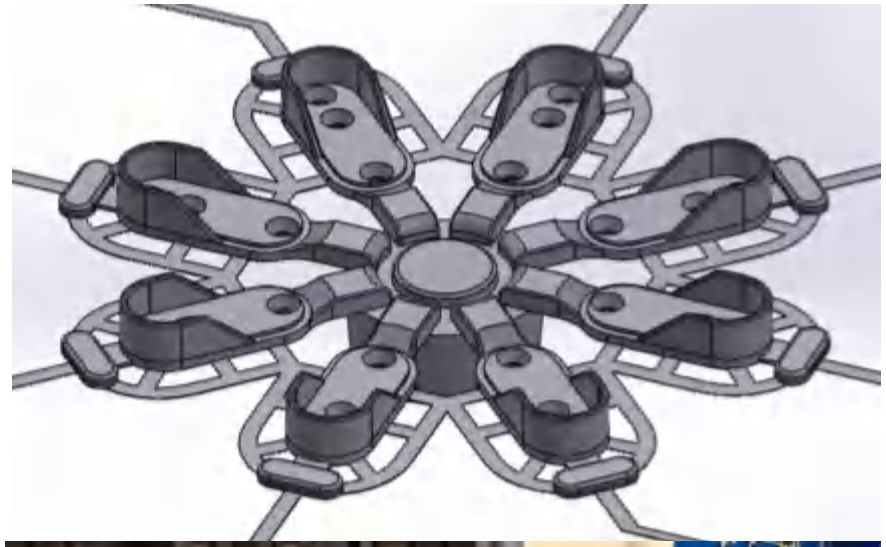
10T Clamping Force



Process Optimization

Process Optimization

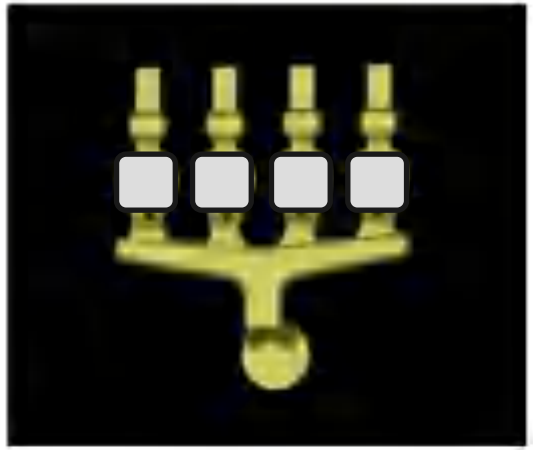
GISS VSC – Multi-Cavity

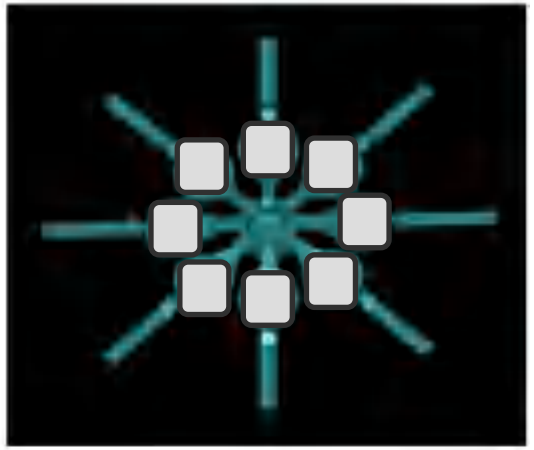


GISS Casting System – Multi-Cavity

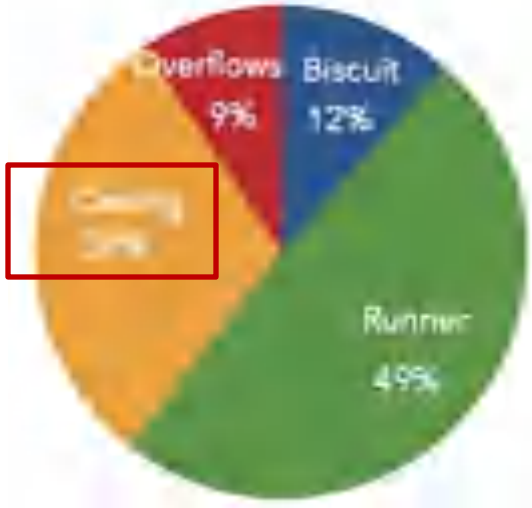
GISS VSC 100T – Commercial Machine

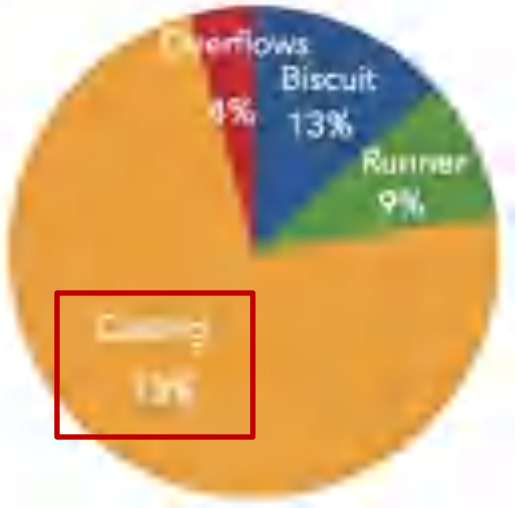
Key Benefits





1 kg –> 300 g

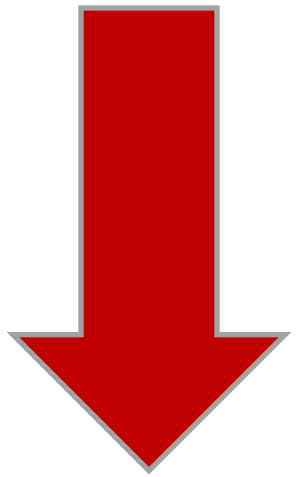




1 kg –> 730 g

Key Benefits

COST

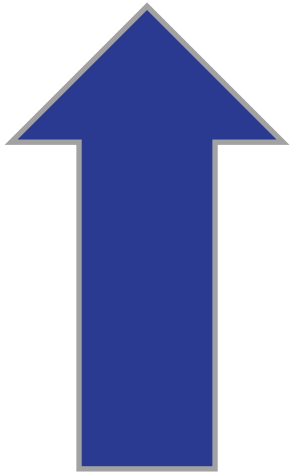


FUTURE

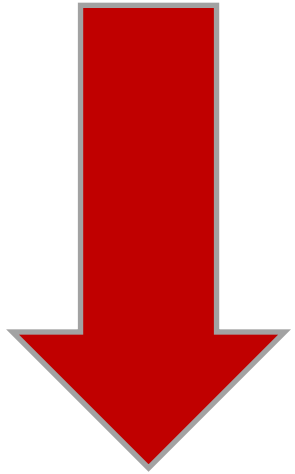
GISS FutureCast

GISS FutureCast

QUALITY

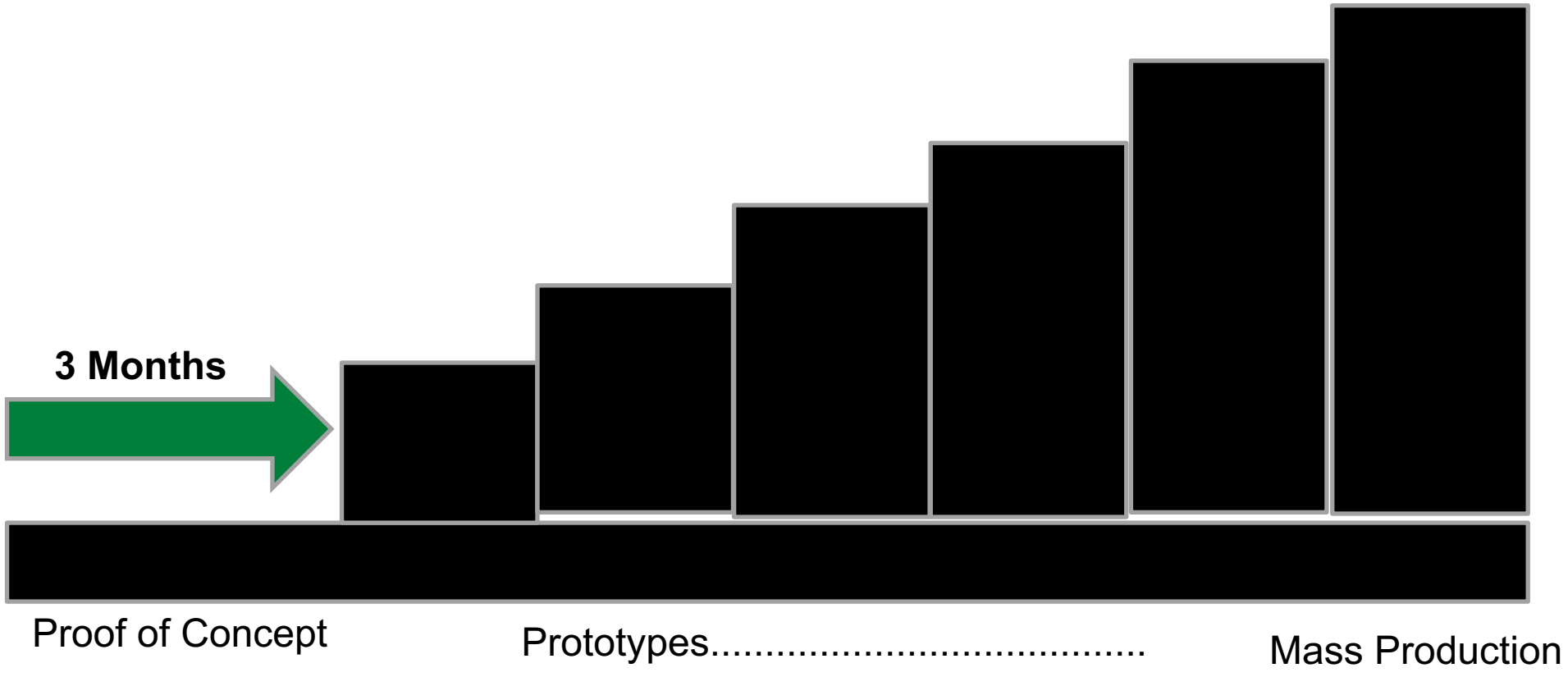


COST



TARGET

GFC Status



GFC Potential Benefits

- Able to cast any metals and alloys, including lightweight and high-strength forging alloys such as 6xxx and 7xxx alloys
- Near net shape casting, possible to achieve > 95% materials yield
- Near zero porosity and near zero defect is achievable
- Possible to achieve uniform microstructure
- Possible to eliminate the heat treatment process to achieve desired properties
- Possible to eliminate the use a die lubricant
- Possible to achieve all-electric design, so possible to use 100% renewable energy
- Near zero air pollution
- Small machine footprint
- Small die


COLORIS

ColoriS Buddha

ColoriS Vessuwan

ColoriS Mortar

ColoriS Dumbbell

ColoriS Dumbbell

ColoriS Luggage

ColoriS EV TukTuk

ColoriS Sound

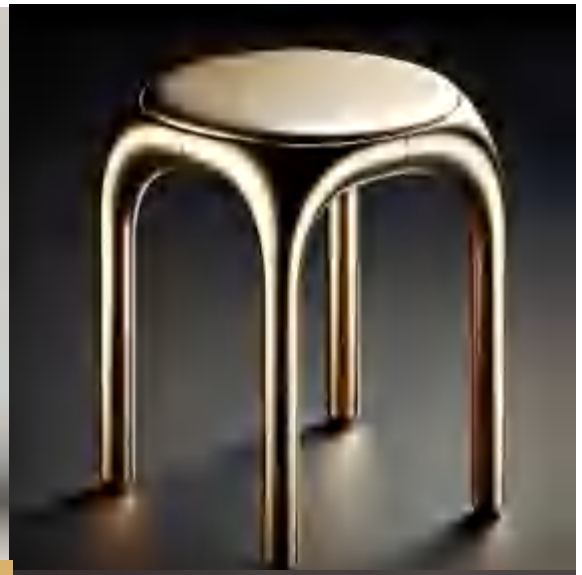
ColoriS Home


Water Hose
Adaptor is
Included

ColoriS Gifts

ColoriS Gifts

ColoriS World



Future

AI Robot

Future Applications

Future

GISS Technology

GISS HPDC | **GISS GDC** | **GISS SF** | **GISS VSC**

Turnkey Service | Strategic Partners | GISS Global Network

Make the Casting World Better!
Thanks!