金屬粉末注射成形的現在與未來 - 中國與台灣

Status Report and Expectation of MIM: Present and Future of Metal Injection Molding in China and Taiwan

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摘要
Abstract

2015年，可稱是大**中華MIM產業第四個十年的元年**，經過兩岸同胞過去的齊心努力，以及德美日的先進供應商導引,MIM技術得以公平，和平的在中國 - 世界製造中心這片土地上，綻開朵並且結果，讓我們共同分享這美好時代的開啟。

2015, I claim this year is "**the first year of MIM industry on Taiwan and China of 4th decade**". Chinese and Taiwan technical teams effort in the past several years, and we thanks in advanced suppliers guiding from Germany, American, and Japan also. From tooling simulation design, mold fabrication, material preparation, feedstock kneading, feedstock pelletizing, injection molding, de-binding, sintering, post treatment, and inspection technology to MIM products shipping, each stage of the MIM process had blossom fruit and mature with public, fair, and peace in this land of world manufacturing center - China. Let us share this age of beauty been open.

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三十功名塵與土 八千里路雲和月
(宋.岳飛- 滿江紅)

這是中國宋代名將 - 岳飛的名作詞曲，取其中兩句來描述各位從事MIM行業的先進們!向您們致敬！

The above sentence were from Chinese poetry. The author is a star general :Yue Fei. Them are very fit to describe all MIM industry makers in Chinese and/or Taiwan. Let me transfer them in English as below (Just for fun!):

白話文

我們在粉末與喂料之路努力了三十個年頭；

穿越八千里路, 日月星辰陪我們渡過

English

We worked on powders and feedstock through three decade. (since 1985 ~ 1994, 1995 ~ 2004, and 2005 ~ 2014)

We walked through eight thousand miles company with the moon and clouds.

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- 綜觀大中華
  Overview of MIM industry in China and Taiwan
- MM技術在中國得以爆發的元素
  Elements of MIM technology can be popularized in China
- 明星產品
  Star products review
- 開創下一個黃金十年
  Let’s open up next golden decade
- 結論
  Conclusion

ABC是我們的導師和朋友, 不是敵人

重力和摩擦力是我們的敵人
Gravity and friction are our enemies.

Dr.Q, PIMA-CN

Arburg 阿伯格 – 德國 注射機
BASF 巴斯夫 – 德國 MIM喂料
Cremer 克萊默 – 德國燒結爐

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綜觀

Overview of MIM industry in Taiwan and China

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金屬粉末注射成形的製造流程
MIM process flow chart

材料形式 Material forms

製程 Process

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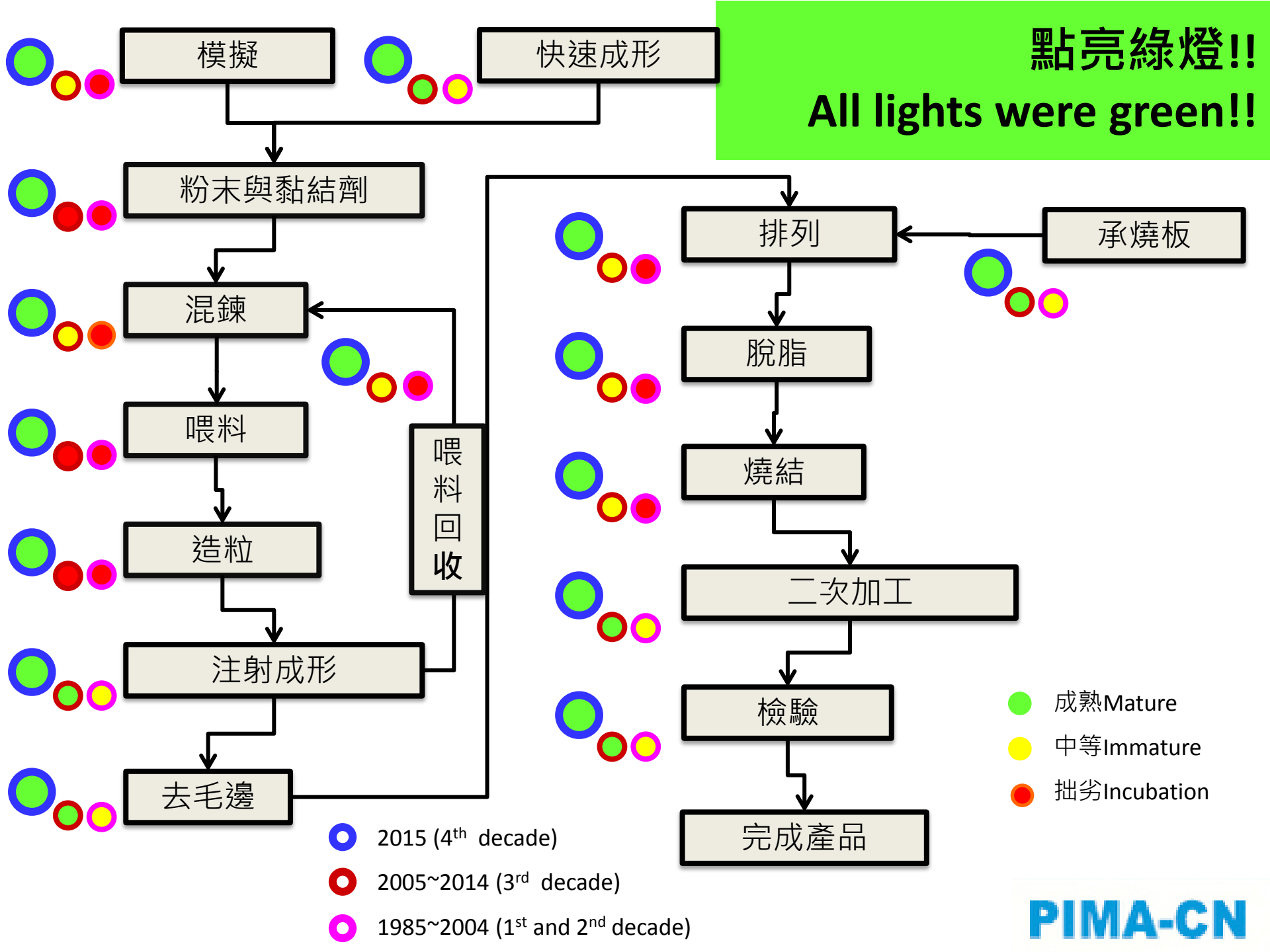
點亮綠燈!!
All lights were green!!
模擬
快速成形
粉末與黏結劑
混鍊
喂料
造粒
注射成形
去毛邊
喂料回收
排列
承燒板
脫脂
燒結
二次加工
檢驗
完成產品
成熟Mature
中等Immature
拙劣Incubation
2015 (4th decade)
2005~2014 (3rd decade)
1985~2004 (1st and 2nd decade)
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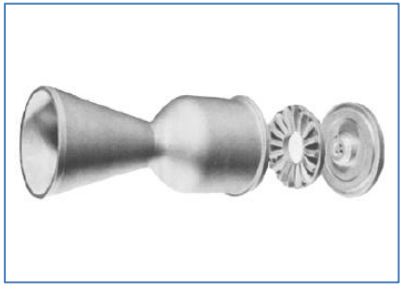
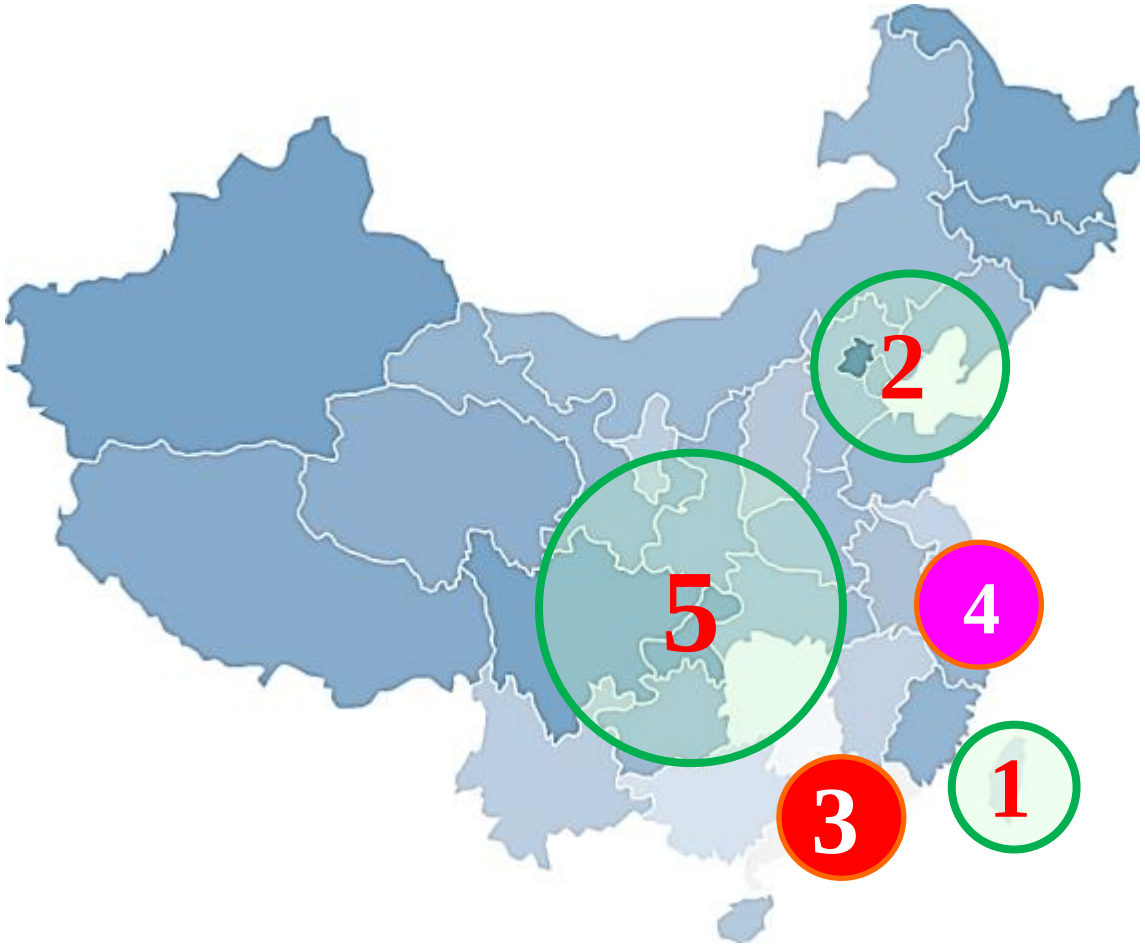
大中華金屬粉末注射最早的發展
The earliest MIM of Taiwan and China



Parmtech first MIM part

- Global MIM beginning in the America
  - 1920s’ CIM
  - 1970s Dr. Raymond E. Wiech Jr. was the first MIM researcher
  - 1970s Parmatech was the first business company
- **台灣 Taiwan**
  - 1987 YITEC transferred technology from Japan YITEC. It was the first company.
  - 1988 Profess K.S. Huang (黃坤祥教授) from Profess R.M. German, RPI MIM Lab. Setup the first MIM lab. in university Taiwan.
- **中國 China**
  - 1995 Academician and Profess Boyun Huang started the MIM lab. in university Central South.
  - 1996 JinZhu was the first business company

大中華區MIM工廠的分布
Distribution of MIM factories



1. Taiwan. Earliest into MIM industry on 1970s'. ~30 factories. (Small and middle size)
2. Beijing area: about 15 factories. (Small and middle size)
3. Pearl River Delta: highest density of MIM factories due to there is the 3C products manufacturing center of the world. Over 80 factories in this area.
4. Yangtze River Delta: Here is next battlefield of MIM in China. Largest size factory in here. Over 40 factories in here.
5. North-west zone: new area less than 15factories.

兩岸MIM工廠至少200家!!(統計至2015/10)

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世界與中國的MIM產業比較
Capability of MIM of World v.s. China

(Red Text were status of China compare with the world wide.)

- Large quantity 200,000 per year of the world/ 20,000 ~ 1,000,000 per day at least
- Small and complex shapes/ More thinner and appearance requirements
- 75 features/ less than 50 features
- 25mm length/ less than 20mm or over 150mm length (Record: ϕ240mm or 300mm length)
- 5~10g mass/ less than 1g or over 2000g mass (Record was 2700g. 5400g tried in this summer.)
- Standard materials/ Major in SUS 17-4PH and 316L
- Near full density/ High gloss on surface
- Competitive properties of fully density material / Same requirements

* Notes
Reference data: Profess R.M. German & Dr. Sander Atre, Powder Injection Molding - Global Market, 2014

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台灣與中國MIM的特別紀錄
Special recorded of MIM in Taiwan and China

- Highest density of MIM factory in Pearl Rivers Delta area. (over 50~)
- Large quantity over 6,000,000 pcs per day and keep six weeks in peak season of one part.
- 45 model start tooling at same time (one month) of SIM trays.
- Dimension of final product: ϕ240mm (will be go to ϕ 350mm) / 300mm length/ 35mm thickness
- One piece weight of 5400g possible
- From 0% to 100% mass production in three months by customers' requirement.
- Batch type vacuum furnace with a 240L graphite box is standard.
- Stainless steel (SUS 316L & 17-4PH) and heavy alloy products (W-Ni-Cu) by MIM process demand has increased year by year
- POM base feedstock over 60% makers used. It is the main effect of a MIM factory could running without material preparation process in China.
- Only less than 5% MIM makers use thermal de-binding base feedstock

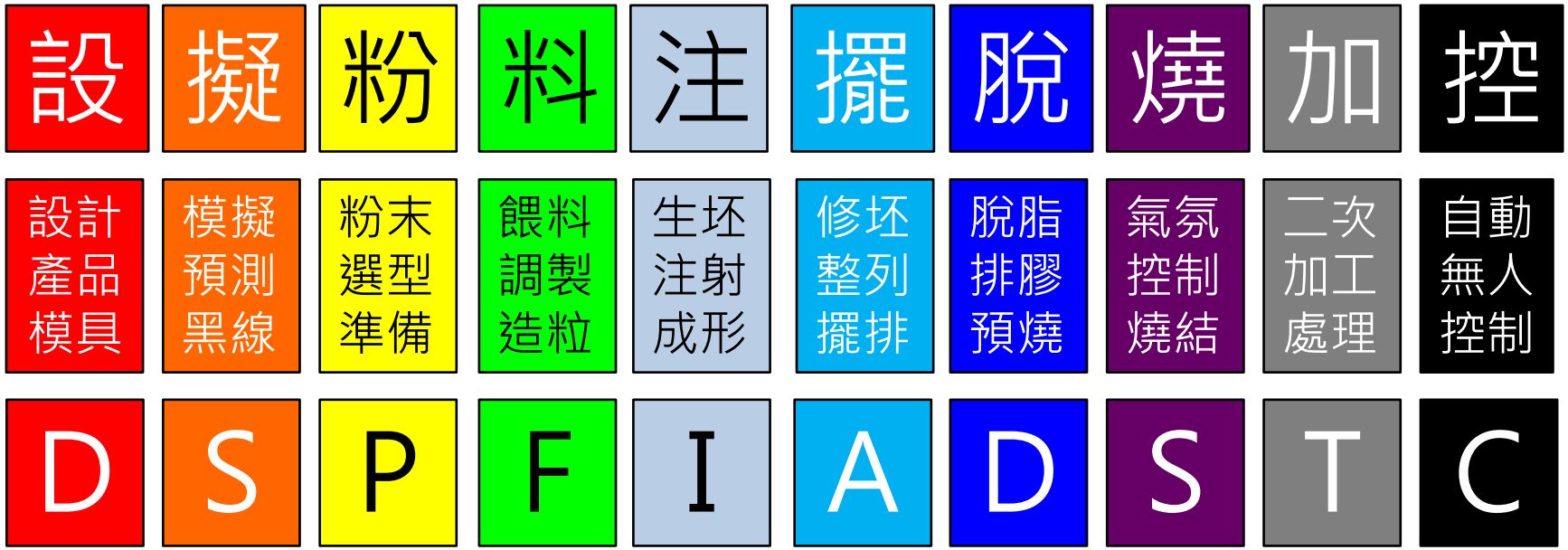
MIM標準生產線單元
Standard manufacture cell : 1-3-1-1

- **The 1-1-3 cell include:**
  - **One** hybrid mixer
  - **Three** sets injection machine (50~90 tons)
  - **One** batch type vacuum furnace with 240L graphite box
  - **One** batch catalysis de-binding furnace with 300L steel box
  - 20 employees for OP. and 2 engineers
  - 3~5 sets molds for production, 1~2 sets molds for development
- 10 million RMB ($1.6 million USD) sales amount per year (90% efficient at least) of the 1-1-3 cell
- **Scale MIM factory:**
  - Micro size: 1 ~ 2 cells (240L ~ 480L)
  - Small size: 3 ~ 5 cells (720L ~1200L)
  - Middle size: 6 ~10 cells (1440L~2400L)
  - Large size: > 10 cells with continue (progressive) furnace
- **Vacuum furnace : 468L to replace 240L (graphite box) already in middle of 2015. The new MFG cell maybe changes to 1:5:1:1with double capacity than the old MFG cell.**

2015年以前MIM製造單元是ABC指標
MIM MFG cell standard by ABC before 2015

- **Arburg index:** Hydraulic system to Large size MIM part
- **BASF index:** CIP (Carbonyl Iron powder) and Catamold® feedstock
- **Cremer index:** 1 XL = 10 liters pre hour = 10L/hr
  - 330cmX330cmX90cm = 9.8L ~~10L
  - 1XL * 24 hrs = 240L = 日本島津真空爐(批次爐霸主1970~2013)
  - 240L *20 (days of month) * 10 months = 4800L, it is a basic production cell product 800,000RMB (130,000USD) in one year at least.

2015年中國重新定義MIM製造程序
We re-new define of MIM MFG process



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台灣與中國的MIM趨勢
Trend of Taiwan and China

- China
  - M style of MIM product scale – Max., Min., and Mass volume
  - MIM parts for smart phone were living products of China MIM factory
  - MIM application has been spread gradually
  - Management system progress too slow effects of automotive and medical part procurement orders
  - Material preparation process become a most important key

- Taiwan
  - Wide products application of MIM
  - Large factory transfer to China for production due to customer requirement
  - Chinese technical ability improvement makes Taiwan manufacturers are facing a threat of survival

MM技術在中國得以爆發的要素
Elements of MIM technology popularizes in China

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MIM製程與設備的標準化

標準製造單元形成的製程: 混-射–脫–燒
Standard manufacture cell : 1-3-1-1

四大關鍵製程技術透明化與裝備標準化
混煉造粒 / 射出成形 / 催化脫脂 / 氣氛燒結

中國MIM工業崛起的關鍵點
Key points of MIM industry rise up of China

In order by time and explanation of red text on follow pages only

- **2008** Core of the manufacture center of the world. (Example: Laptop PC)
- 2009 Black box broken of binder recipe crack
- 2010 APPLE accepted the MIM process for metal parts production
- 2011 BASF feedstock price down and POM base feedstock became major material
- 2012 Close cooperation of MIM makers and vendors
- **2013** Quick localization of MIM hardware and software suppliers in China. POM base patent valid
- **2014** Smart phone of Chinese brands rise up lightning

世界工廠的核心
Core of the manufacture center of the world

- **Talent shortage**
  - Employee + Engineers + Managers
- **Government policy for MIM**
  - Land + Tax concessions + Resources support (Electric power, water system, and traffic network)
- **Orders**
  - Industry applications + Supplier chain concentrated + Market requirements
- **Capital**
  - Hot money into MIM industry
- **Capability**
  - Knowledge and technology learning + Recruit and jump

本土化: 1.硬體裝備
Localization – I: Hardware development

- Optimization as lightning of all special MIM equipment
- Keeping quality and cost down
- Example brands: (equipment for four major process)
  - 混 Feedstock preparation and recycle process: **亙易隆 GREELONG**
  - 射 Injection machine: **海天HAITIAN (hydric type) and 長飛亞ZHAFIR (electric and hybrid type)**
  - 脫 Catalysis de-binding furnace: **斯百睿SIBARER/星特爍 SINTERZONE**
  - 燒 Batch type vacuum furnace : **恆普真空 HIPER**

MIM業界ニュース

GM-next
Survey & Breakthrough

恒普真空　真空脱脂焼結炉は国内MIM市場での販売量が高まる

2014年08月26日

金属射出成形（MIM）は伝統的なプラスチック射出成形技術に基づいて発展し、我が国に導入後急速に発展している。この技術は適用材料の範囲が広く、少し加工が必要だが、生産効率が高く、量産のコストが低いなど優勢がある。21世紀の最も先進的な金属部品制作技術と呼ばれている。
金属射出成型を採用し金属部品を生産する過程で、焼結はMIM金属部品の密度を決める重要な段階である。真空で部品を焼結したら、脱炭を制御し、また焼結の過程では金属製品に汚染されることを嫌う。そのため、真空焼結炉は射出成形企業で広く使用されている。しかし伝統的真空焼結炉は専用の脱脂設備で脱脂しなければならない。そして再輸送あるいは人工で原料を焼結炉に運ぶ。エンジニア時間が長く、設備にの投資も増加する。
恒普真空は専門の焼結炉生産メーカーであり、国内の長江デルタでMIM焼結炉市場の90%以上を占め、珠江デルタで70%の市場占有率がある。長期の研究を通じて、同社は伝統的な真空焼結炉に基づいて、一種の真空脱脂焼結炉を開発した。脱脂、焼結二つの工程を同一炉で行う。脱脂をするとき、真空ポンプで脂類物質を排出させ、汚染を避ける。調査によると、同社製の真空脱脂焼結炉はわずか3年登場して、既に100台が販売される。現在この設備は全国のMIM市場での販売量を急速に伸ばしている。
この真空脱脂焼結炉は焼成過程で炉圧による不安定性や焼結製品が不均一に収縮することを避け、製品の変形と緻密化の不均等などの欠点を軽減する事ができる。真空脱脂焼結炉はMIMで使われて、焼結製品の品質を高め設備の投資コストを減らし、今後徐々に多くのMIM部品メーカーに受け入れられていくだろう。

在2013年到2015年, 恆普真空燒結爐的市場交貨佔有率

長江三角洲市場佔有 90%; 珠江三角洲市場佔有 70%

性價比高過島津真空爐取代其在中國MIM的地位

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本土化 – 2. 材料, 分析軟體與工廠管理系統
Localization – II: Material, software, and system

- Material of MIM = Powder + Feedstock (from north to south)
  - BeiJing ATM (Powder) Winners (Feedstock)
  - ShanDong ZTP (Powder + Feedstock)
  - JiangSu TianYi (Powder)
  - HuNan: Hengi (Powder)
  - JiangXi Yuean (Powder + Feedstock)
  - GuangZhou, Research Institute of Non-ferrous Metals (Powder + Feedstock)
  - ShenZhen, Cadam (Feedstock)
- Simulation Software
  - **MODEX3D from CoreTech System Co., Ltd. It was a best software to predict dark mark (powder and binder segregation) on green part before tooling development.**
- **Automatic of robots and CCD inspection system**

Moldex3D
MOLDING INNOVATION

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市場應用的崛起 – 智慧手機打前鋒!
Smart phones brands rise up lightning in China

- **Top ten brands of smart phone**
  - COOLPAD
  - GIONEE
  - HTC
  - **HUAWEI***
  - LENOVO
  - MEIZU
  - **MI***
  - OPPO
  - **VIVO***
  - ZTC

***Top three in China**

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明星產品
Star products review

本處所提為例舉, 許多產品外型是不能洩漏的, 請理解並諒解!

What is a star product ?

1. Over 50,000 pc/day record at least
2. Continue order keeps one year
3. Three large size vendors to supply it at least

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用於筆記本電腦的轉軸與凹凸輪
Cam for hinge of laptop and notebook PCs

代表供應商：新日興與兆利

Legend

- Year: 2005~2008
- Major material : Fe-2Ni & SUS 440C
- Application: Two pair cams were assembly into a laptop or notebook PC for screen and main body connection.

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黑莓手機與平板電腦的金屬標牌
Metal logo for Black Berry handheld devices

Legend

- Year: 2009
- Major material : SUS 316L
- Application: Mirror like metal logo of Black Berry cell phone and smart phone

代表供應商：晟銘電

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智慧手機的支架
Kick-stand of smart phones

http://www.htc.com : HD7

代表供應商 : 晟銘電與新日興

Legend

- Year: 2010
- Major material : Fe-2Ni
- Application: Kick-stand of smart phone

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平板電腦的轉軸支架與電源供應接頭
Kick-stand and power adapter of tablet PCs

Legend

- Year: 2011
- Major material : SUS 316L and 17-4PH
- Application: Kick-stand and power adaptor head of Surface, it was on the tablet PC of Microsoft – “Surface”.

代表供應商 : 晟銘電與安費諾

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蘋果電腦產品的連接器接頭外殼
Metal housing of lightening cable of APPLE devices

http://store.apple.com

Legend

- Year: since 2012
- Major material : SUS 17-4PH
- Application: Metal housing of lightening cable of Apple handheld devices

代表供應商 : 富士康, 昶聯與晟銘電

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金屬按鍵
Metal buttons of smart phones

代表供應商 : 富馳

Legend

- Year: 2013
- Major material : SUS 316L
- Application: Metal buttons of all smart phones

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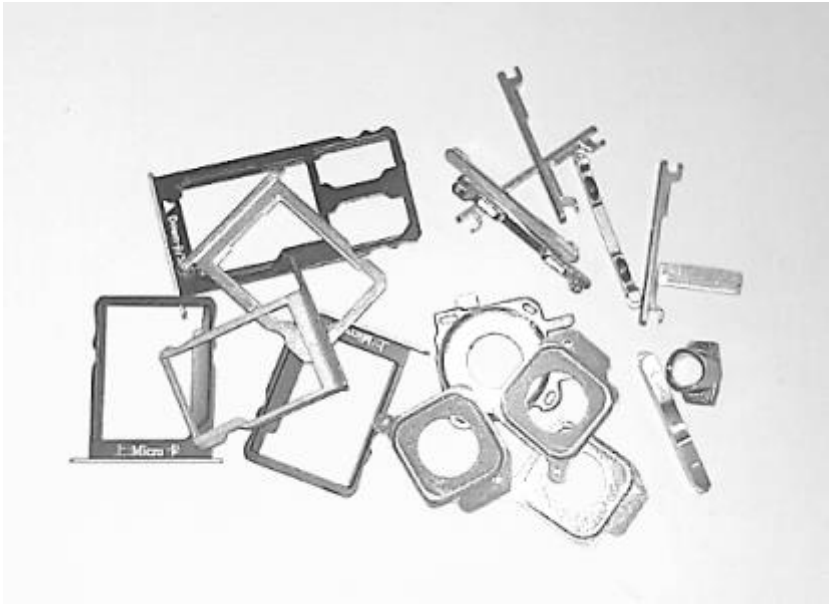
智慧手機的MIM三劍客 – 卡托/鏡頭裝飾圈/按鍵
SIM trays and camera decoration ring of smart phone



Legend

- Year: 2014
- Major material : SUS 17-4PH and 316L
- Application: SIM trays (Single and dual tray) and decoration ring of camera of a smart phone

代表供應商：中國內地70%MIM廠

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開創下一個黃金十年

Let’s open up next golden decade

2015 to 2024

走出世界工廠, 才有下一個機會

World factory out, next opprtiumuty come in

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中國品牌產的智慧手機用MIM零件的份額
Market prediction demand and the total sales amount of MIM parts on Smart phone application in China

Prediction MIM Parts amount of Smart phone, 2015.3								
Brand	Demand	Parts name						Total number of sales
	Amount	SIM tray	Camera R.	Flash R.	Butt.	I/O port	Hinge	
Huawei	30,000,000	4						120,000,000
OPPO	30,000,000	4	2					180,000,000
VIVO	20,000,000	4						80,000,000
MI	5,000,000	4	2	1	5			60,000,000
MI	30,000,000	4	2		3			270,000,000
MEIZU	5,000,000	4		1				25,000,000
ZTE	10,000,000	4						40,000,000
LENOVO	30,000,000	4	2	1	3			300,000,000
COOLPAD	30,000,000	4	2	1	3			300,000,000
ASUS	5,000,000	4				1		25,000,000
HTC	30,000,000	6	2					240,000,000
							Tatol	1,640,000,000

1,640 million of RMB
(6.4 hundred million USD)
This number without APPLE/SAMSUNG/SONY parts

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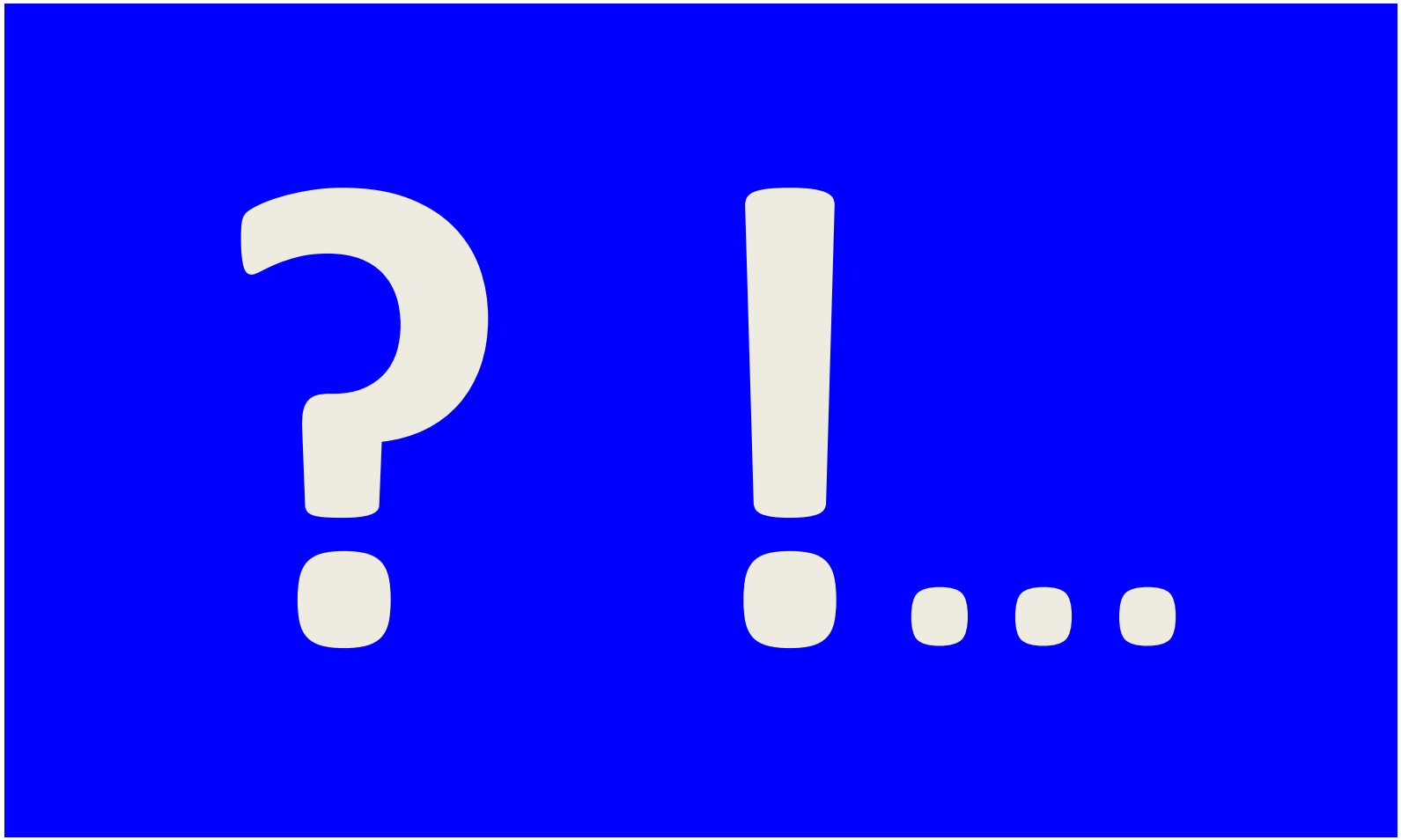
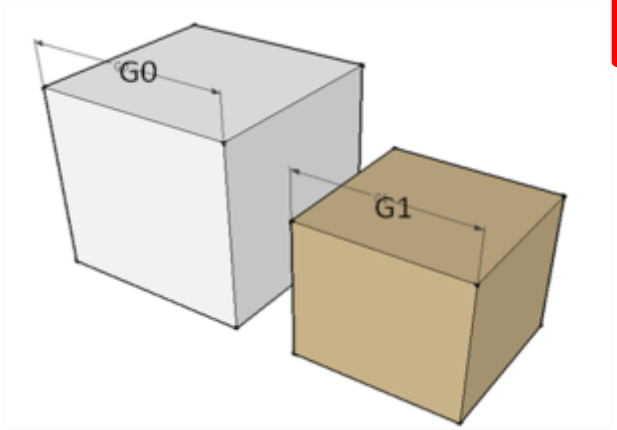
沒有卡托的時代
Risk: e-SIM will be replace real SIM card



高裝載量的喂料挑戰
High Volume Powder Loading to face new challenge

New POM Base Feedstock Tech.
OSF forward to 1.126

1.160~1.169
Present recipe application

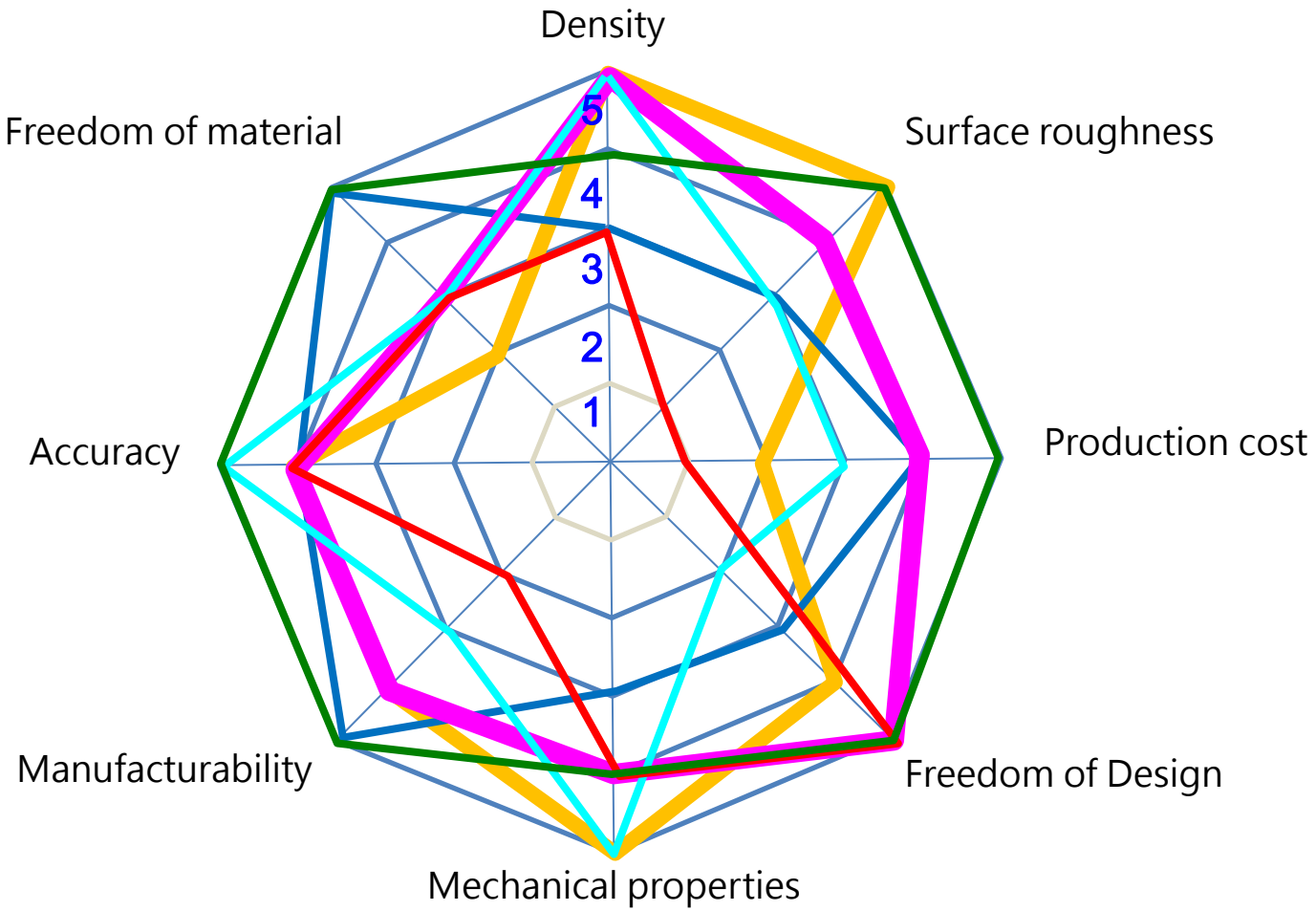


Volume rate vs. OSF			
Total volume	Metal	Binder	OSF
1000	700	300	1.1262
1000	692	308	1.1306
1000	675	325	1.1400
1000	650	350	1.1544
1000	640	360	1.1604
1000	630	370	1.1665
1000	625	375	1.1696
1000	620	380	1.1727
1000	600	400	1.1856
1000	575	425	1.2026
1000	550	450	1.2205
1000	500	500	1.2599
1000	450	550	1.3050
1000	300	700	1.4938

烧结完成所有粘结剂全部烧除

強敵環繞的金屬加工製程技術
Enemies surrounded of metal part process

- Liquid metal® process
- Forging
- Lost-wax casting
- Press Molding of PM
- 3D Printing
- MIM



P.S. Each process without second process by CNC machining

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MIM技術的真正普及原因

1.快速產能爬升, 超過其他製程(搭配整形與CNC加工)

2.注射成形的熟練度高, 塑膠廠可以快速轉型

3.技術圈小, 打破黑盒子, 分享快速

4.華人圈的努力, 完成標準化製程與裝備

個人感覺
Personal feelings

繼續向前吧! MIM同業們, 更歡迎年輕人加入!

Keeping go on, MIM industry need more younger people join.

感謝日本與歐洲ABC盟友對MIM工業的領導!!

Thanks for Japan & ABC to lead MIM industry forward!

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Thank you & end!

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