

# Status of MIM in Greater China

大中華區金屬粉末注射成形現況

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台灣區電腦輔助成型技術交流協會:粉末注射成形與材料科學技術委員會主任委員

中國粉末注射成型聯盟:輪值主席

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**Many a little makes a mickle, and unity is strength.**

聚沙成塔、眾志成城



# Topic of today

今日主題

- ✓ **Status of the MIM industry in Greater China** 大中華區的MIM產業現況
- ✓ New technologies 新技術
- ✓ New applications 新應用
- ✓ Challenge since 2017 今年起的挑戰

# The rise new power of MIM – Asia

崛起的新MIM勢力 – 亞洲



## Top 10 MIM factories

(Sintering Cp.>10,000 Liters)

10大MIM廠有日產10000升能力

### China 中國

- Gian (Changzhou/Dungguan)
- Future (Shanhei/Shenzhen)
- Amphenol(Hangzhou/Yunnan)
- CNI (Gaungzhou)
- Foxcon (Gaungzhou)
- UNEEC (Dungguan)

### Singapore 新加坡

- DYT (SG/Anhui, China)

### India 印度

- Indo-MIM (Bangalore/Texas, USA)

### Taiwan 台灣

- SZS (New Taipei City)
- TYP (Tauyuan/Wujiang)

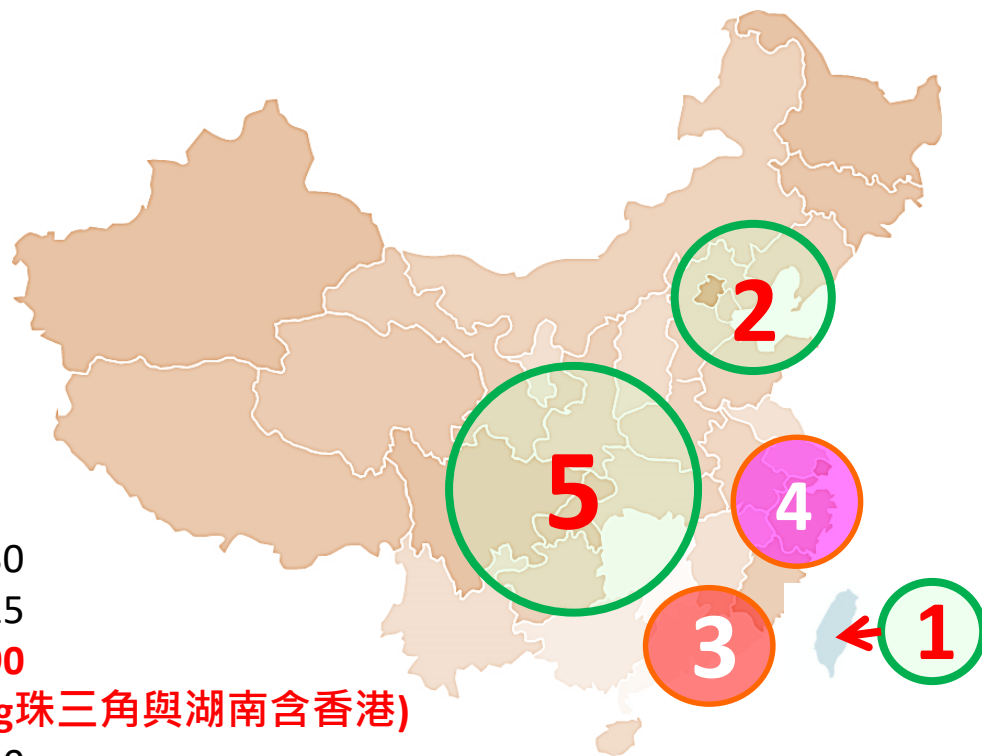
- Most Asia MIM factories in pool of blue dotted line. 大部分工廠位於藍色虛線中
- Necessity of progressive furnace (SZS expect) 連續爐的必要性
- All top 10 MIM factories were APPLE AVL (Approval Vendor List). 十大工廠都是蘋果公司的合格供應商

# Distribution of MIM factories in Greater China

大中華區MIM工廠的分布

Sort according to start year  
排序案啟動年份

1. Taiwan 台灣地區 >30
2. North area 華北地區(京津冀魯) >15
3. **South area 華南地區** >90  
**(Pearl River Delta, Hunan, and Hong Kong 珠三角與湖南含香港)**
4. East area 華東地區 >40  
(Yangtze River Delta 大長三角含浙江、福建)
5. West area 西北地區 >15



- 200 MIM factories running until 2016 統計到2016大中華區超過200家MIM工廠
- The highest density out of the world of MIM factory in zone 3 . 第3區MIM工廠密度是世界最高

# One stop shop street of MIM on Pearl river area

珠三角的MIM一條街(縱貫線)



1. Connection MIM three cities subway will done on 2018 將完成聯通三個城市的軌道交通
2. 50% mobile phones assembly from this area. 世界50%手機組裝在此
3. The highest density of CMF (Color, Material, and Finishing) factories, metal precision CNC machine sets, mold and tooling of duplication. 有著世界最密集的表面處理、數控加工設備以及模具製造工廠
4. Most young people here to achieve entrepreneurial success 最多年輕人在此創業成功

• The MIM school will setup in Changan town of Dongguan city. It is on the center of one stop shop street. MIM教室將設立在東莞市長安鎮，位於MIM一條街的中點。

# Total amount of 3C devices possible use MIM part in G.C.

大中華區3C產品可能使用MIM零件的總值預估

Brand 品牌	MIM Parts 產品	Amount (M pcs)百萬件	Assembly price 總價 (RMB)		Total output (M RMB)
APPLE	i-phone	200	Structural	5	100
APPLE	i-Pad + mini Pad	100	Structural	6	600
APPLE	Air-book	30	Hinge assembly	12	360
APPLE	I/O plug	600	Lightning +TYPE C	1	600
Microsoft	Surface/Pad PC	30	Hinge assembly	15	450
Huwei	Smart phone	120	SIM tray/Ring/Button	3	360
OPPO	Smart phone	70	SIM tray/Ring/Button	3	210
VIVIO	Smart phone	70	SIM tray/Ring/Button	3	210
MI	Smart phone	60	SIM tray/Ring/Button	3	180
Other brands	3C device	200	Structural	2	400
MIM assembly total amount					4,370
Pure MIM parts output without C/F treatment (60%)					2,620

CMF = Color顏色/ Material 材質/ Finishing 表面處理

# Total amount of MIM market on G.C., 2017

## 大中華區MIM市場估計總值

MIM Products	Product application	M RMB	Possible area
3C device 消費性電子商品	<ul style="list-style-type: none"> <li>SIM tray/structural 智能手機</li> <li>Wearable/ watch 穿戴裝置</li> <li>Laptop/Smart phone 筆電本</li> </ul>	4,370	1, 3, & 4
Metal hardware 五金產品	<ul style="list-style-type: none"> <li>Power tools and lock industry 工具</li> <li>Kitchenware 廚具</li> </ul>	500 150	2, 3, & 4
Cosmetic hardware 裝飾五金	<ul style="list-style-type: none"> <li>Zipper 拉鍊</li> <li>Bag hardware 包包五金</li> </ul>	200	3 & 4
Military 軍工	<ul style="list-style-type: none"> <li>Weapons 武器</li> <li>Defense tools 防禦工具</li> </ul>	700	1 & 5
	Total amount	5,920	<b>25% of the world</b>

5,920 M RMB ~ 910 M USD

- ✓ MIM process with low carbon emission and less pollution to avoid Haze on China. It is a new opportunity of MIM. MIM製程的低碳排放與低汙染，可以避免霾害。對於MIM來說這是一個好機會
- ✓ I phone 8 of APPLE maybe back to use stainless middle frame. It is a good opportunity of MIM parts also. 傳言蘋果第八代手機又回到不鏽鋼中框，這又是一個MIM零件的好機會。



# Milestone of MIM market and technology development

## MIM市场与技术的发展軌跡

### Market 市场

- Incubation phase until mainstream production technology /由孵化阶段直到成为主流生产技术

- Growing number of company foundation /基础公司转型加入越来越多
- MIM into NB hinge application / MIM进入笔记本电脑转轴

- APPLE began touse MIMparts /苹果公司开始采用MIM零件
- Strong growth on MIM industry in Asia /亚洲区MIM产业成长強勁

- Local smart phone began touse MIMparts/中国产手机开始使用MIM零件
- Production equipments started localization in China /生产设备中国本地化

- Age of Integration process with MIM is coming /整合MIM制程的时代来临



- Sinking number of binder variations /黏结剂的成分缩减
- Wax base become major binder system /蜡基成为主流粘结剂

- Increasing material diversity /材料的多样性逐渐增加
- 3C products used MIM parts /MIM零件开始进入3C产品

- Better tolerance /更好的公差
- Catalytic de-binding system and POM base binder present /催化脱脂和聚甲醛基粘结剂出现

- Process simulation (Mold flow)/制程模拟技术 (Moldex 3D 模流)
- Micro MIM parts <0.1g /微小MIM零件
- Huge MIM parts >200g /大型MIM零件

- More special material applies MIM process /更多特别的材料应用MIM制程
- Zero defect on MIM part /零缺陷产品

### Technology 技术



# Key parts of the rise of G.C. MIM industry (I)

大中華地區MIM產業興起的關鍵MIM零件之一

## Base of optical fiber connector since 2010 光纖連接器基座



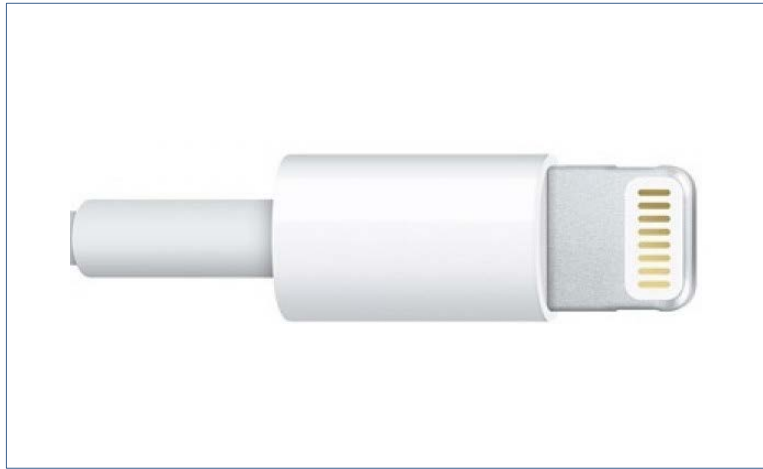
Base of optical fiber connector for high speed signal transmission ( Ceramic is Zr2O tube with stainless tube, CIM picture from CCTC 潮州三環提供) 高速信號傳輸用的光纖基座

- MIM 304L or 316L 不鏽鋼 304L 或 316L
- MIM + LASER welding with SUS and ceramic tube in assembly as above picture. Accessory of serve PCBA devices. 6~10 sets in one PCBA for light firer connection. 總成必須焊接不鏽鋼管和陶瓷如照片。在電路板上需要配置6~10組作為光纖連接使用。
- Over 2 billion pieces. (Sustained increase ), cumulative output value greater than 2 billion RMB. 至少有兩億個交貨紀錄(持續增加) ，估計有兩億人民幣的產值以上
- **Maximum record :50 million pieces pre years. 最高出貨紀錄每年五千萬個**

# Key parts of the rise of G.C. MIM industry (II)

大中華地區MIM產業興起的關鍵MIM零件之二

## Lightning connector male side since 2012 雷霆接頭公端



Male side of the APPLE Lightning connector  
蘋果的雷霆連接器公端

- MIM 17-4PH 沉澱硬化不鏽鋼17-4PH
- MIM + CNC + Nickel plated 金屬注射成形 + 數控加工 + 鍍鎳
- Lightning connector is a shared accessory of most APPLE devices. 雷霆接頭作為大部分蘋果裝置的連接器
- Over 10 billion pieces. (Sustained increase ) Cumulative output value greater than 10 billion RMB. 超過10億個出貨量(持續出貨中) 估計超過10億元人民幣產值。
- **Maximum record : 6 million pieces pre day and keeping six weeks. This was a very special record in MIM 3C product.** 最大出貨紀錄：連續六週至少每日6百萬顆的的巨量紀錄，在3C產品使用MIM零件是前所未有的。

# Key parts of the rise of G.C. MIM industry (III)

大中華地區MIM產業興起的關鍵MIM零件之三

**SIM tray of smart phone since 2012** 智能手機的卡托



**SIM tray of Smart phone**  
智能手機的卡托

- MIM 17-4PH (major) or 316L 沉澱硬化不鏽鋼17-4PH(大部分)或316L
- MIM + Re-strike + PVD + Laser curving. And, some special materials assemble with MIM (include: plastic insert molding, plastic assembly, and AI CNC parts) 金屬注射成形 + 整形 + 真空鍍膜 + 雷射雕刻，許多特別的CMF處理都被用上甚至組合其他製程(如塑膠包射、與塑膠件、鋁陽極後件的組裝)
- Applying in smart phone of China brand. 中國品牌的智能手機主要應用
- Over 10 billion pieces. (Sustained increase ) Cumulative output value greater than 50 billion RMB. 超過10億個出貨量(持續出貨中) 估計超過50億元人民幣產值。
- **Over 50% MIM factories made this product. (2015 and 2016) 在過去兩年至少一半中國MIM工廠賴以維生的產品**

# New MIM orders, where they are?

說好的，我們的新訂單呢？

MIM Orders are never reduced, but the quality is not good still. This is a common problem on the MIM industry in Greater China. 大中華區的MIM的訂單從沒有減少，但是品質卻一直沒有做好。這是一個普遍的問題。

# We knew already

現在我們知道

## Major deformation points of MIM parts MIM產品變形主要的因素

- ✓ Feedstock with high friction force during process 喂料本身的高摩擦力
- ✓ Gravity influence drooping of MIM green part 重力變形影響
- ✓ Phase change during heating process 熱製程過程的相變化

# New technology

新技術

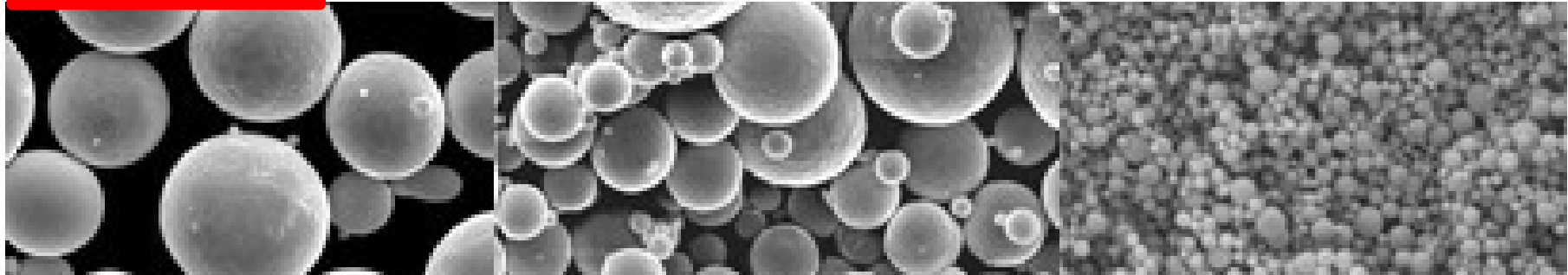
**Go to the future, let's starting from powder** 進入“未來”，從粉末開始

- ✓ Return to classroom and pick up MIM textbooks again. 重新回到教室、拿起MIM課本
- ✓ Don't just rely on 3C products 不能只依靠3C產品
- ✓ Do not make appearance MIM parts only. The mechanical properties have to care also. 不能只會製作外觀件，卻將機械性質棄而不顧。
- ✓ Upgrade ours knowledge and improve qualities for MIM parts. 提升我們的知識與改善MIM產品品質

# Powder grade from a powder vendor

粉末廠出產粉末等級

Mesh # 篩網數	$\mu\text{m}$	Output rate 產出率(%)	Suitable product 合適的產品
+300	>50	100%	Thermal coating, PM, and 3D printing
-300 ~ +500	30 ~ 50	75%	3D printing and MIM adjusting
-500 ~ +800	20 ~ 30	50%	MIM(structural/exterior decoration)
-800 ~ +2000	7.5 ~ 20	5%	MIM(High polishing surface)
-2000~+10000	1.5 ~ 7.5	2~3%	$\mu\text{MIM}$ , Hard metal forming, and cer-met compound for MIM process.
-10000	<1.5	1%	



**Powder vendor supply powder specification: -500#. There are too much fine particles (-2000#) will interfere MIM feedstock during molding process. MIM粉末供應商依規格是將-500#的粉末出貨，實際上有太多過細的粉末**



# Product grade depend on powder grade

根據產品匹配粉末等級

Product Grade 產品等級	A (Exterior decoration) 外觀	B (Structural) 結構
A	<p><b>AA</b></p> <ul style="list-style-type: none"> <li>• Powder: 95~100% G + U/W</li> <li>• Product : Watch, necklace , and high polishing wearable parts. All surface mirror like requirement</li> </ul>	<p><b>AB</b></p> <ul style="list-style-type: none"> <li>• Powder: 90~95% G + U/W</li> <li>• Product : MIM with a high polishing surface (Most APPLE MIM parts like this.)</li> </ul>
B	<p><b>BA</b></p> <ul style="list-style-type: none"> <li>• Powder: 80% G + U/W// 100%U</li> <li>• Product : Camera ring, metal key, and button with a diamond cut edge.</li> </ul>	<p><b>BB</b></p> <ul style="list-style-type: none"> <li>• Powder: 100%W</li> <li>• Product: Dimension requirement first. Surface allows hair-lining and sandblasting.</li> </ul>



**G**

Gas spraying 氣霧化  
Relative Roundness= 1



**U**

Water and gas spraying 水氣聯合  
R.R= 0.75~0.85



**W**

Water spraying 水霧化  
R.R. < 0.65

# MIMs' Feedstock

金屬注射成形的喂料

## Parallel use of specifications and homemade feedstock

必須能並行使用市售規格品和自家配方

- ✓ Wax base change to POM base 以塑基取代蠟基
- ✓ Solvent de-binding change to Catalyst de-binding 催化脫脂取代溶劑脫脂
- ✓ Feedstock adjustment in house 自己會調製喂料
- ✓ 100% specification feedstock used change to 50%. 標準規格喂料改變至少一半為自家配方

# Feedstock OSF depend on powder grade

根据粉末匹配喂料收缩比

**OSF(Oversize Shrinkage Factor) should be change when you design a new part. 整體收縮因子必須依據產品來進行修正**

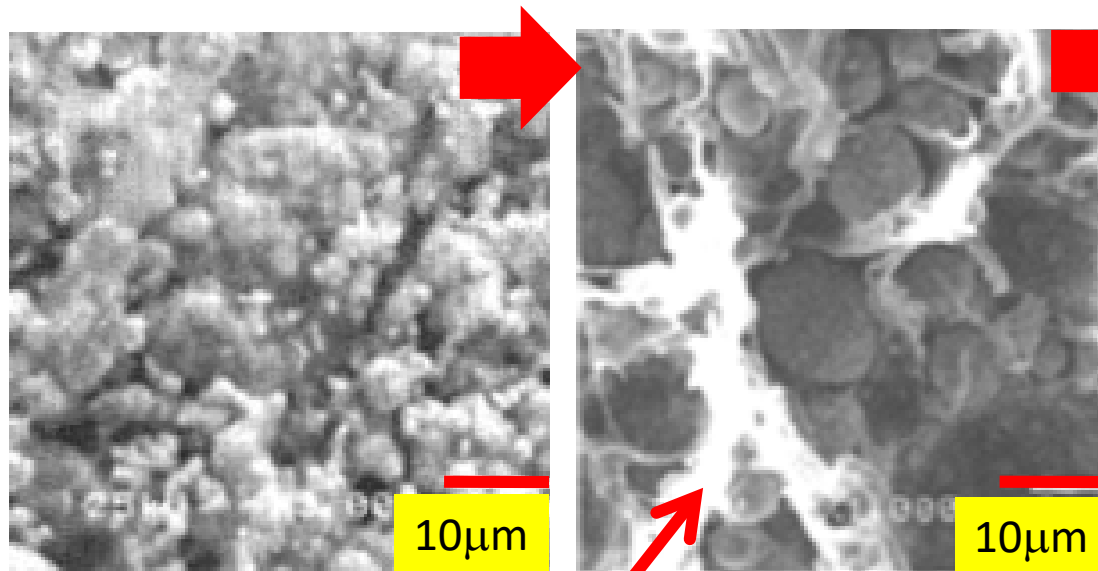
Product Grade 產品等級	A (Exterior decoration) 外觀	B (Structural) 結構
A	<b>AA</b> <ul style="list-style-type: none"><li>• Powder d50: 7~8um</li><li>• OSF : 1.19~1.30</li><li>• Due to powders are very fine with high friction force.</li></ul>	<b>AB</b> <ul style="list-style-type: none"><li>• Powder d50: 10~12um</li><li>• OSF : 1.19 ~1.21</li><li>• Fine powders will interfere MIM feedstock during molding process.</li></ul>
B	<b>BA</b> <ul style="list-style-type: none"><li>• Powder d50: 10~12um</li><li>• OSF : 1.168~1.21</li><li>• Fine powders will interfere MIM feedstock during molding process.</li></ul>	<b>BB</b> <ul style="list-style-type: none"><li>• Powder d50: 12~15um</li><li>• OSF : 1.128~1.19</li><li>• Add some rough powder to enhance fluidity of feedstock.</li></ul>

# An upgrade of catalytic de-binding

升級的催化脫脂

**Movable brown parts with high strength** 能夠移動的高強度棕坯(脫脂坯)

After de-bind 脫脂後



Green part  
生坯

Brown part  
棕坯

- ✓ Increasing  $N_2$  gas flow and temperature during last stage of de-binding process. 在脫脂最後階段提高氮氣流量與溫度
- ✓ Residue low molecular weight polymer sintered. 殘留低分子量塑膠的燒結
- ✓ Brown part with high strength could moved. 棕坯成為具有強度可以移動

Cotton wool material are low molecular weight polymers residue in brown part after catalytic de-binding. They were skeleton support agent in residue binder. (like PP/PE) 催化脫脂後可以見到毛絮狀的低分子塑膠。它們是殘留粘結劑中的骨架支撐劑(如聚丙烯/聚乙烯)

# Carbon control

碳控制

**Applying thermal process to drive carbon content to enhance MIM part quality** 用熱製程來控制碳含量使MIM產品品質提升

- ✓ Carbon, a double face role during sintering process 碳在燒結過程是雙面角色
- ✓ Change atmosphere for carbon control 改變氣氛獲得碳控制
- ✓ Binder is a carbon source still 粘結劑一直是碳的來源
- ✓ Return to correct detecting way for carbon residue 碳控制回到正確的碳分析工具
- ✓ Sintering challenge of +/-1°C temperature control 燒結精密控制爐溫的挑戰

10μm

# New application

新應用

**Strong by 3C and return metal hardware** 藉3C產品壯大，回歸到五金零件

- ✓ Long wave order is better than fusion order 長單比潮單(短且急)好
- ✓ Cost down, cost down, and cost down. Is it a 3C order in the future? 只能降價會是3C產品的未來?
- ✓ High precision and quality is the best warranty 高精度和高性能才是生存保障

# MIM process go back for SIM tray

記憶卡托又回頭採用MIM製程

## ✓ Non MIM process brings unexpected trouble 非MIM製程帶來的困擾

- Plastic SIM tray deformation causes abnormal signal reception 塑膠熱變形導致異常
- Aluminum Alloy SIM tray due to overall color consistency requirements, so we must use one piece of material for machining. This way can avoid cosmetic difference of the finished product after anode treatment. This results in a waste of materials, low processing efficiency, and can not produce a large amount on short time. 鋁合金材質要求顏色均一，並須採用塊材雕刻加工，以避免陽極發色異常，造成材料的浪費、加工繁複以及短期量產困難

## ✓ Advantages of MIM process are confirmed in SIM tray 卡托採用MIM製程的優勢被確認

- Many vendors can support this parts. 有眾多供應商可支持
- High efficiency and economy. 高效率且經濟
- Mass production volume on short time is possible. 短期產量爬升可能
- High structural strength. 產品有高強度
- Non magnetic stainless material can apply in the future. 無磁性鐵基材料問世
- Plastic and aluminum alloy parts can assemble with MIM part 塑膠和鋁合金零件可與MIM件組合

**MIM SIM tray experience reduction in 2016. This year, it return to the smart phone again. 經歷2016年的減量採用，MIM卡托又再回到智能手機身上!!**

# We subdivide segment the MIM process

我們細分MIM制造程序

PD	TS	QD	PS	FM	IM	DA	DB	PA	SC	SP	AC
產品設計	模具模擬	品質設計	粉末選型	餵料混造	生坯注射	修坯擺排	酸脫熱脫	預燒修整	氣氛燒結	二次處理	自動控制

1. PD (Product Design): 產品先期的設計
2. TS (Tooling Simulation): 模具的模擬
3. QD (Quality Design): 品質設計
4. PS (Powder Selection): 粉末選型
5. FM (Feedstock made): 餵料製造
6. IM (Injection Molding, IM): 注射成形
7. DA (De-burr and Arrange): 修坯與擺盤
8. DB (De-Binding): 脫脂
9. PA (Pre-sintering and Adjustment): 預燒結與調整
10. SC (Sintering Control): 燒結控制
11. SP (Secondary Process): 二次處理與加工
12. AC (Automatic Control): 自動控制

ACMT Tech. Class: MIM – detail 12 process, we start in Dongguan 2017.

ACMT的技術課程：粉末注射成形的12製程, 今年我們在東莞開課



# Conclusion of today

今天的結論

- ✓ **Focus on MIM products quality and MIM education**  
重視MIM產品品質與MIM的教育
- ✓ **Challenging new market applications not 3C devices only**  
挑戰不僅是3C裝置的新市場應用
- ✓ **Willing to invest in innovation and research of new materials**  
願意投入創新並積極研究新材料
- ✓ **Commitment to delivery always – we are Asia team!**  
維持交貨的承諾 – 我們是亞洲團隊



## Acknowledgements (I)

謝誌

Thanks for Pro. German. He is the best teacher and partners of us. (April 2016 MIM class in Shanghai, China) 感謝German教授，我們最好的老師和夥伴(2016.4. 上海MIM課程)

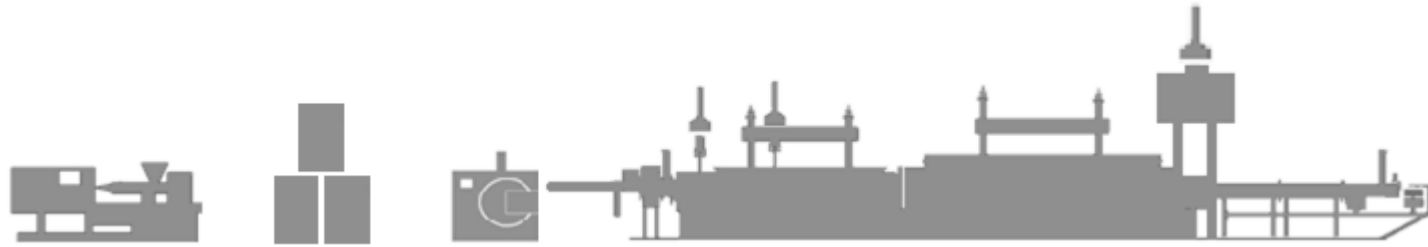
# Acknowledgements (II)

謝誌

**Thanks for ABC from Germany** 感謝德國 Arburg, BASF, 與Cremer

They bring the most advanced equipment and share the latest PIM technology. ABC are our mentors and partners of us , not compete with us. Friction and gravity are MIM enemies. 他們帶來先進的設備並且分享先進的技術，ABC是我們的導師和朋友，不是在MIM的競爭對手。摩擦力和重力才是MIM的敵人。

Dr. Q, PIMA-CN 2015.



**A: Arburg – Molding technology**

阿博格的注射成形技術

**B: BASF - Material and feedstock of PIM**

巴斯夫的PIM材料與喂料

**C: Cremer - Heat treatment and progressive furnace**

克萊默的熱處理和連續爐

# Acknowledgements (III)

謝誌

**The APPLE style** 蘋果的風格

APPLE devices used a lot of MIM parts since 2010 and still running. APPLE is the best company to adopt new technologies of the world. It is a big influence for contemporary. 蘋果裝置從2010年以來一直持續使用MIM零件，它是地表上最勇於採用新技術的公司，蘋果的風格是當代最具影響力。

**We sincerely thank the MIM business opportunities from the APPLE.** 我們真誠感謝蘋果公司所帶來的MIM商機

# Future exist always. But, are we ready yet?

未來已經存在，但我們準備好了嗎？

- ✓ Science never change and exist still. 科學一直存在那裡並未改變
- ✓ When we understand science more, it close future more. 當我們越來越瞭解科學，未來就越接近我們
- ✓ In face, ourselves are the future. 其實，我們自己就是未來

- ✓微-微聚正面力量
- ✓積-積累人類智慧
- ✓分-分享知識快樂

**Thank you!**  
**謝謝您!**

**Go ahead, we are ASIA MIM team! Let's break through together!!**  
亞洲團隊，我們一起加足馬力，困境突圍!!

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