UL webinar

High Flow MIM Binders Suitable for High Precision Parts with Reduced Voids

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Outline

- Introduction : Benefits of POM
- Characteristics of POM
- Reactivity Between POM and Stainless Steel

- Introducing our new binder “PT120” for thermal debinding
- Voids and Mechanical Properties of Sintered Bodies
- Morphology of Green Parts (Analysis)

Introduction : Benefits of POM

MIM processes

Mixing
↓
Pelletize
↓
Injection molding
↓
Debinding
↓
Sintering
↓
Metal products

The fluidity of the binder component changes the molding behavior.

POM is depolymerized by acid and heating. Since POM is depolymerized, it is quickly debinding and is used for both debinding methods.

By using POM without residue, the sintering density can be increased.

Benefits of using POM for binder components

■ **Both catalytic and thermal debinding enable decomposition and removal.**

■ **No residue because it decomposes to the monomer unit.**

Benefits of using High Flow POM

■ **High fluidity improves moldability.**

⇒ **It is also effective for forming thin and small items and for picking up a lot of pieces.**

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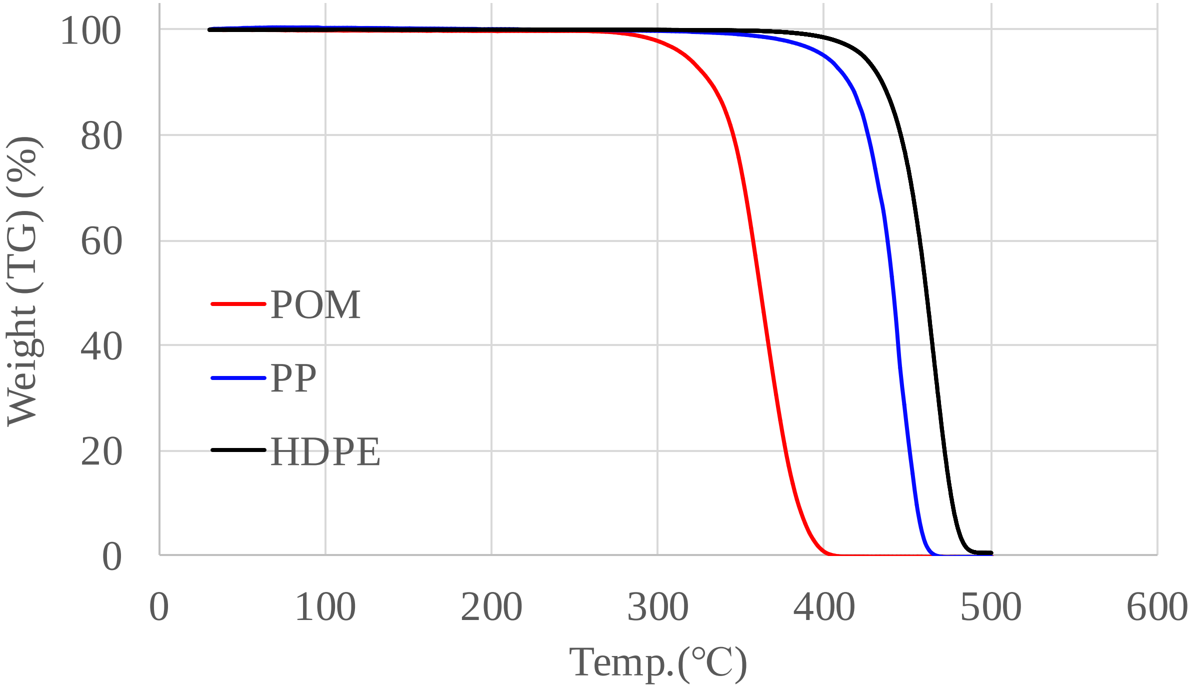
Characteristics of POM : Decomposition

POM undergoes depolymerization due to thermal decomposition and there is no residue

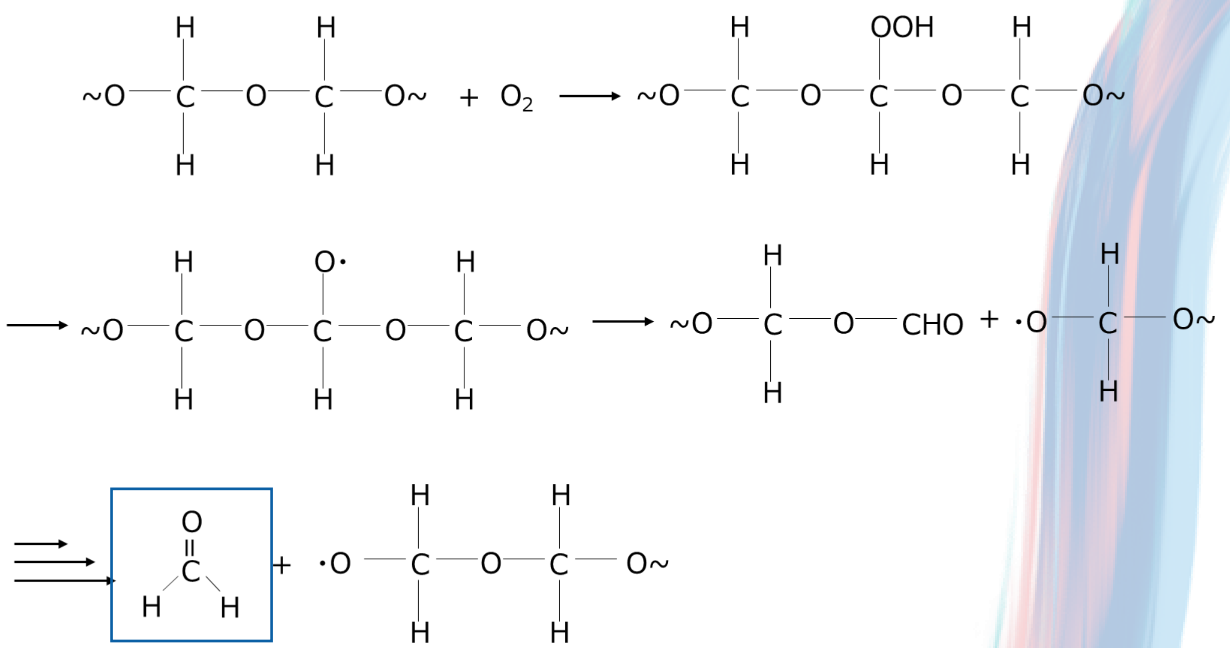
Decomposition behavior of POM and other resins



[Measurement conditions]
Temperature:30℃⇒500℃
Heating rate:5℃/min
Atmosphere:N_2

Residue at 500 °C.
POM : 0%
PP : 0%
HDPE : 0.5%

Mechanism of thermal decomposition of POM.

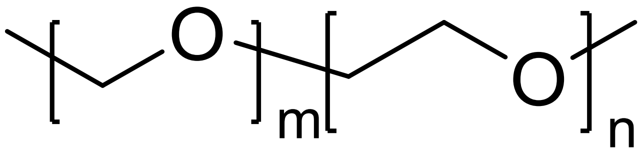


・Since it volatilizes while decomposing to formaldehyde, no residue is left.

Characteristics of POM : Miscibility

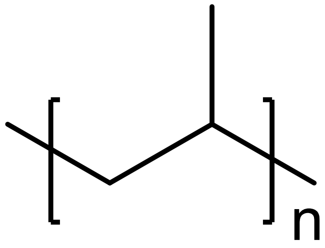
Compatibilizer is required for using POM with other material

	Δd (dispersion)	Δp (polarity)	Δh (hydrogen bond)	Solubility Parameter
POM-C	16.7	10.9	7.6	21.3
HDPE	16.8	2.2	3.3	17.3
PP	16.4	6.4	6.9	18.9
Paraffin Wax	17.1	1.1	2.0	17.4

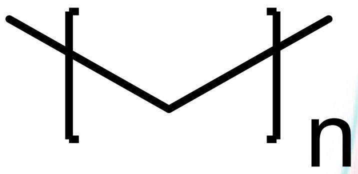


POM-C

immiscible



PP

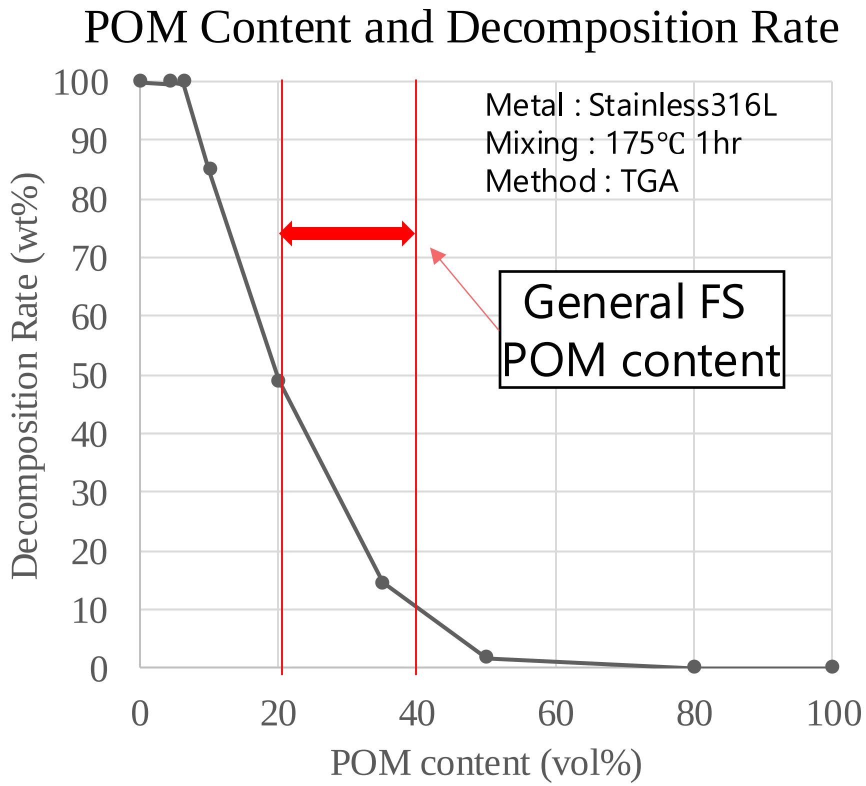


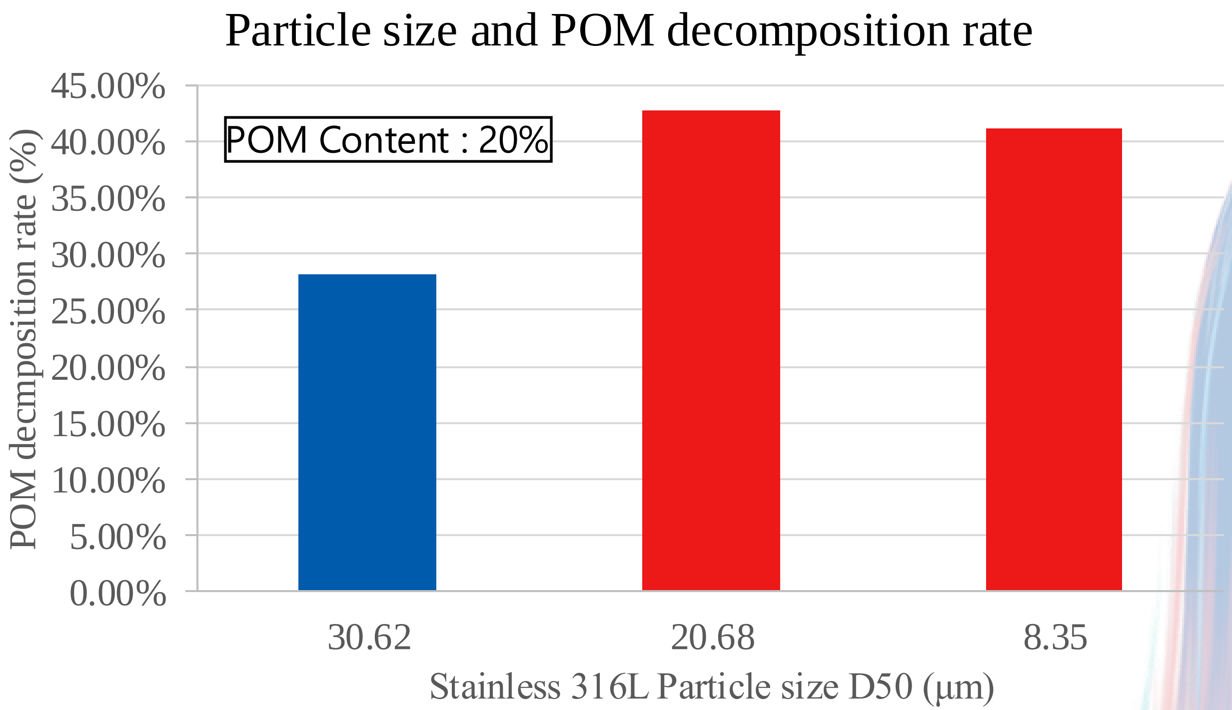
PE and PW

Key Material① : Compatibilizer

Reactivity Between POM and Stainless Steel

Capping reactive sites is necessary for mixing POM with metal powders





Key Material② : Capping Reactive Sites

Reactivity Between POM and Stainless Steel

Capping reactive sites is necessary for mixing POM with metal powders

The reactive sites of the metal powder decompose POM

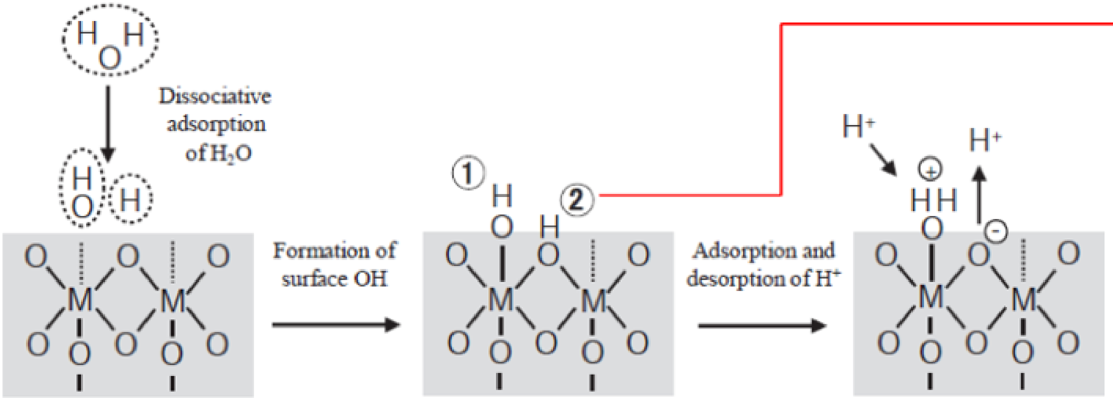
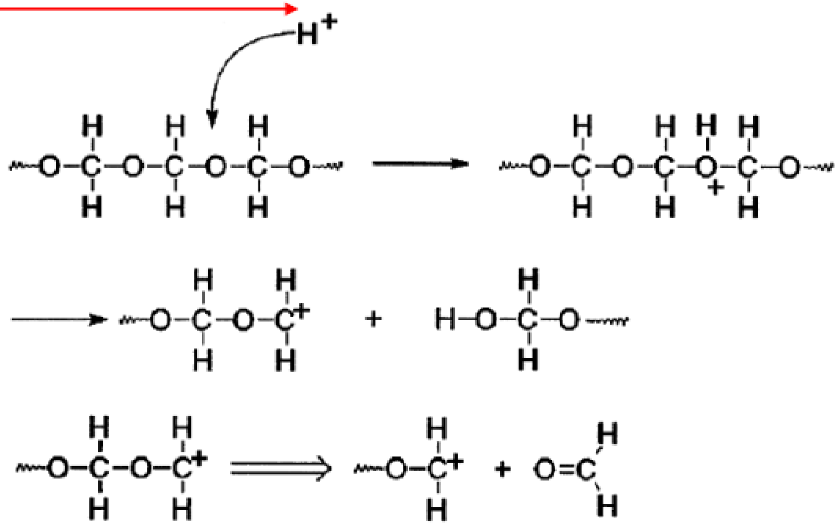


Fig. 1 A schematic representation of surface ionization of oxide layer

$$-\ MOH^0 + H^+ \rightleftharpoons -\ MOH_2^+ \qquad (1)$$

$$-\ M_2OH^0 \rightleftharpoons -\ M_2O^- + H^+ \qquad (2)$$



The same reaction occurs even in metals that have oxides present on their surface

Key Material② : Capping Reactive Sites

Introducing our new binder “PT120” for thermal debinding

What is TENAC™-P PT120 ?

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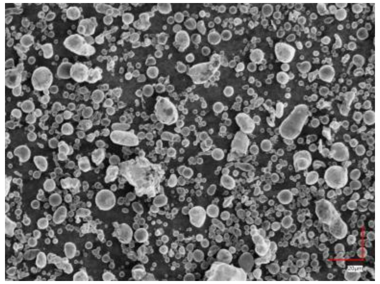

Metal powder

TENAC™-P PT120

Application example
Assistance provided by Sodick Corp.

<Features>

1. All in one binder	*Suitable for Thermal Debinding MIM*
2. Minimal voids	*after sintering process*
3. Excellent fluidity	*Suitable for intricate metal products*
4. Easy to make feedstock	*Just simply mixing with metals(*)*
5. Eco-friendly /sustainable	*No acid, no organic solvent*

*Metal type example: SUS316L powder

Mechanical Properties of Sintered Bodies

PT120 results in the production of superior sintered bodies

Tenac-P PT120	: Improved miscibility and reactivity with Metals Using high flow POM
Binder B	: Not improved. Using not high flow POM (MFR 30g/10min)

ISO2740
test piece

		PT120	Binder B
Metal type		**SUS316L***1	**SUS316L***1
Density	**g/cm³**	7.72	**7.67**
	Standard deviation s	0.00	0.01
Tensile strength	**MPa**	**512**	**470**
	Standard deviation s	**0.7**	65.0
Tensile Strain	**%**	**52.5**	**43.0**
	Standard deviation s	**0.6**	14.8

*1 Note.
-Sintered parts : Binder/Stainless 316L = 35 / 65 vol%
-Metal particle size of Stainless316L: D50=9.3 μm
-Sintering temp.: 1350℃

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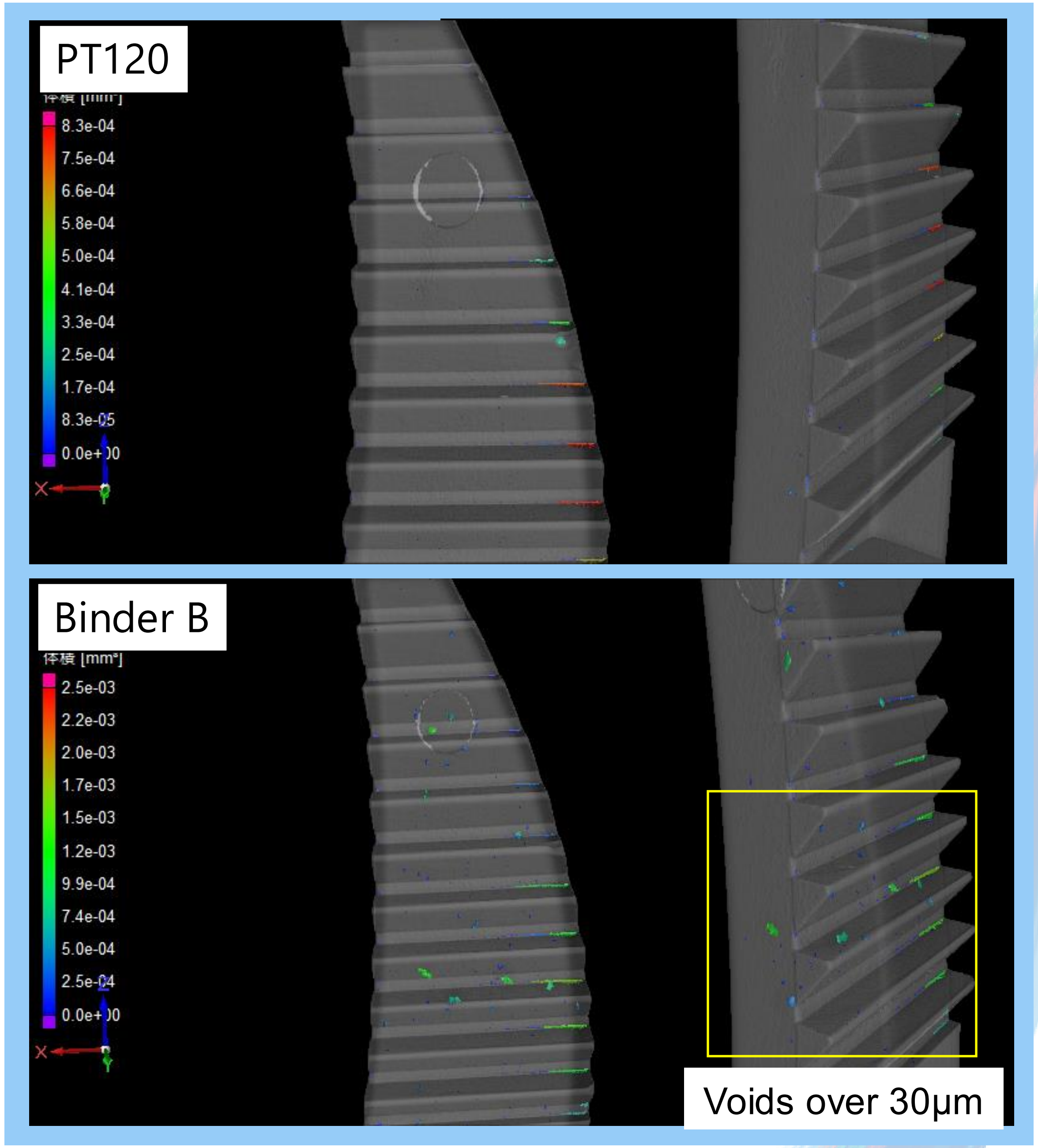
Voids of Sintered Bodies

Sintered Bodies : forceps

Void ratio analysis (X-ray CT)
PT120 : **0.01%**
Binder B : **0.03%**

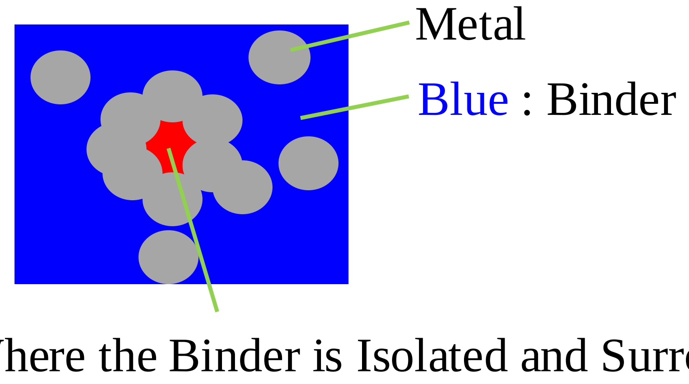
Minimum molding speed
PT120 : **25 mm/sec**
Binder B : **36 mm/sec**

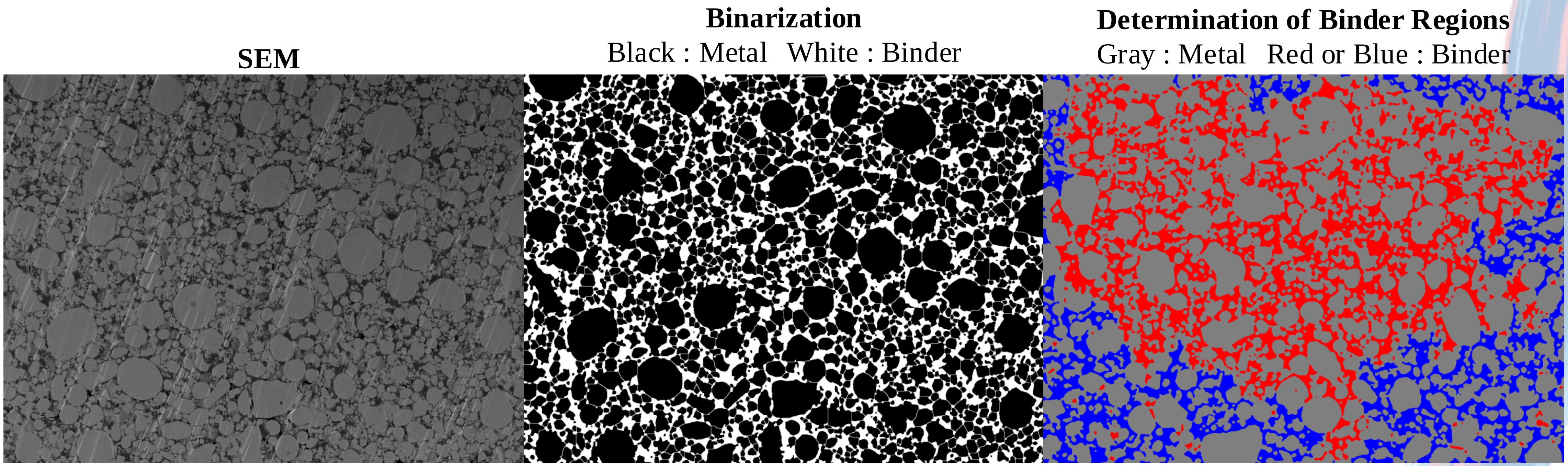
Molding machine : Sodick GL30-LP



Morphology of Green Parts : Method

・Method
Green Parts : ISO2740 test piece
Preparing Observation Surfaces : ion milling





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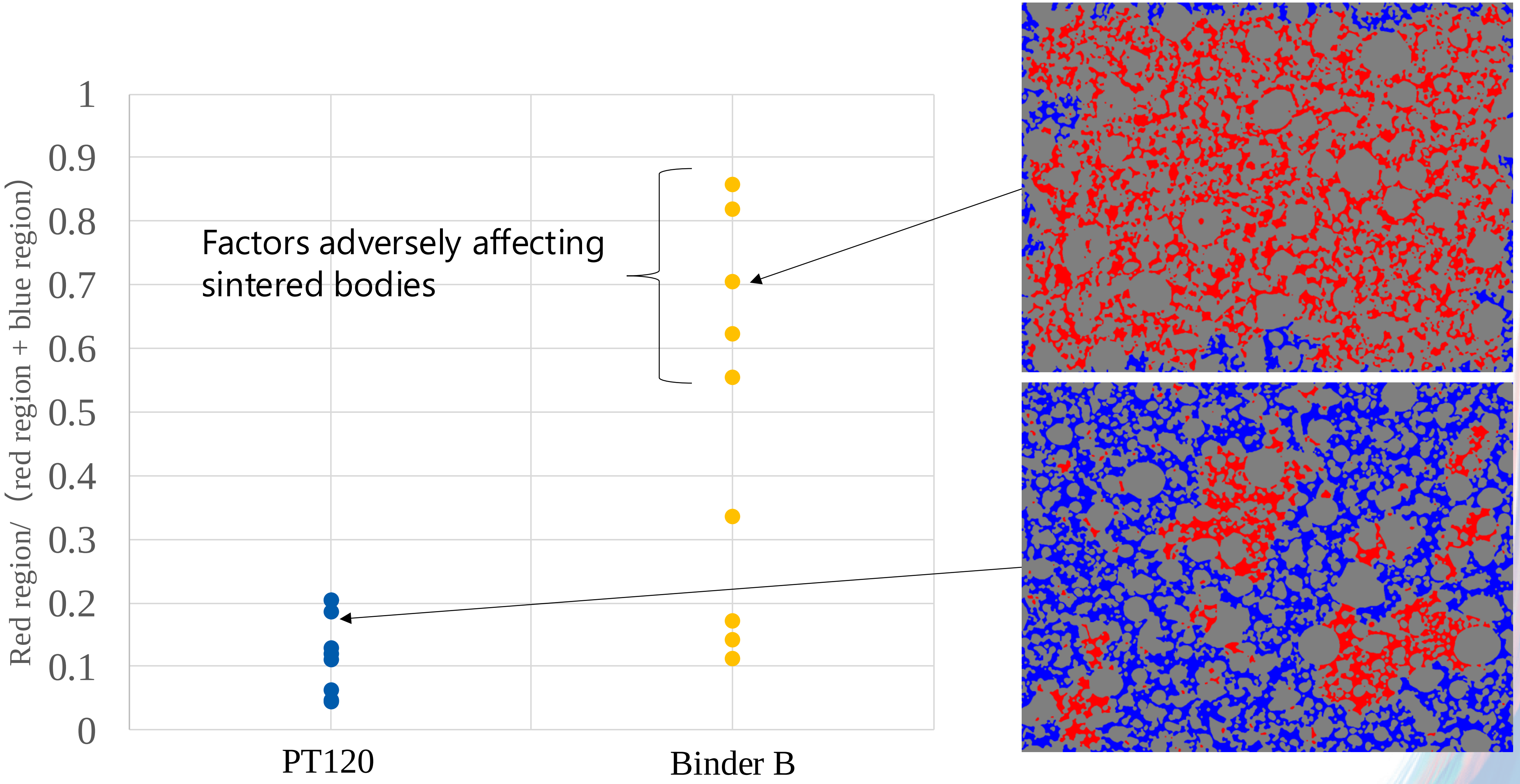
Morphology of Green Parts

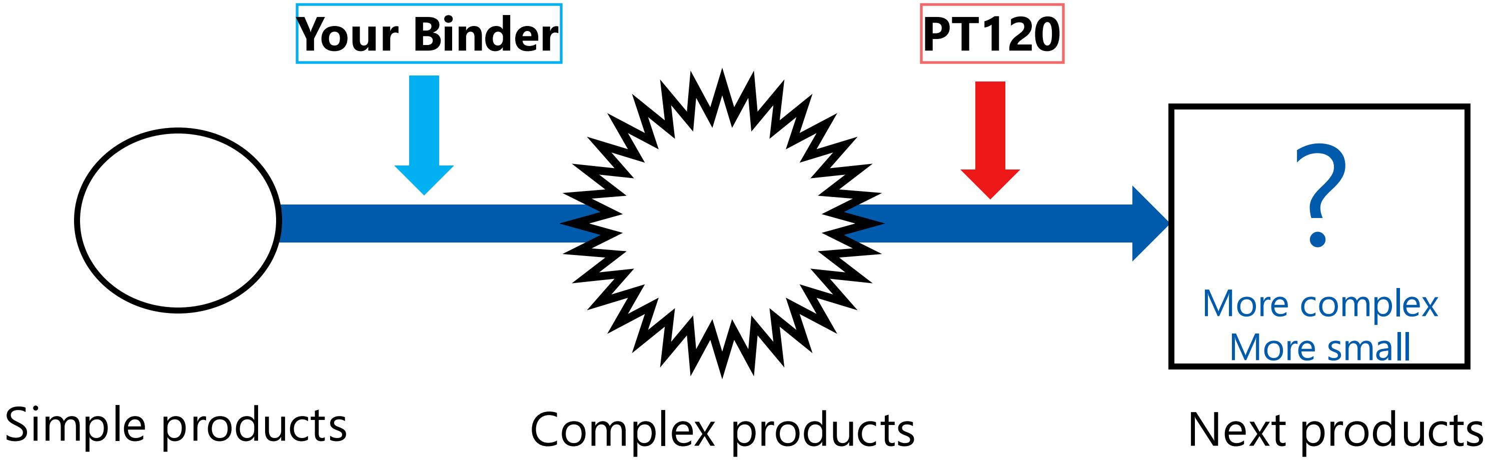
The dispersibility of the metal powder affects the voids and properties of the sintered body



Summary

- **POM**
  advantage : no residue, flowable
  disadvantage : miscible, reactivity
  ⇒**Key points** : <u>Compatibilizer, Capping reaction sites</u>

- **PT120** is characterized by **high flowability** and **less voids performance**



Asahi Kasei's Solutions for PIM

For thermal debinding

TENAC™-P PT120

・Resin, Wax, Additive premix in One Binder
・Boost your productivity & Achieve high-quality!

For catalytic debinding

TENAC™-C FF520

Pellet type

TENAC™-C FF52P

Powder type

・Ultra-high fluidity polyacetal (MFR=120g/10min)
・Available in pellet and powder forms to suit your system

All in One Binder for catalytic debinding (under development)

・Less odor when mixed
・Easy to make feedstock

Sample Arrangements Available

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Creating for Tomorrow