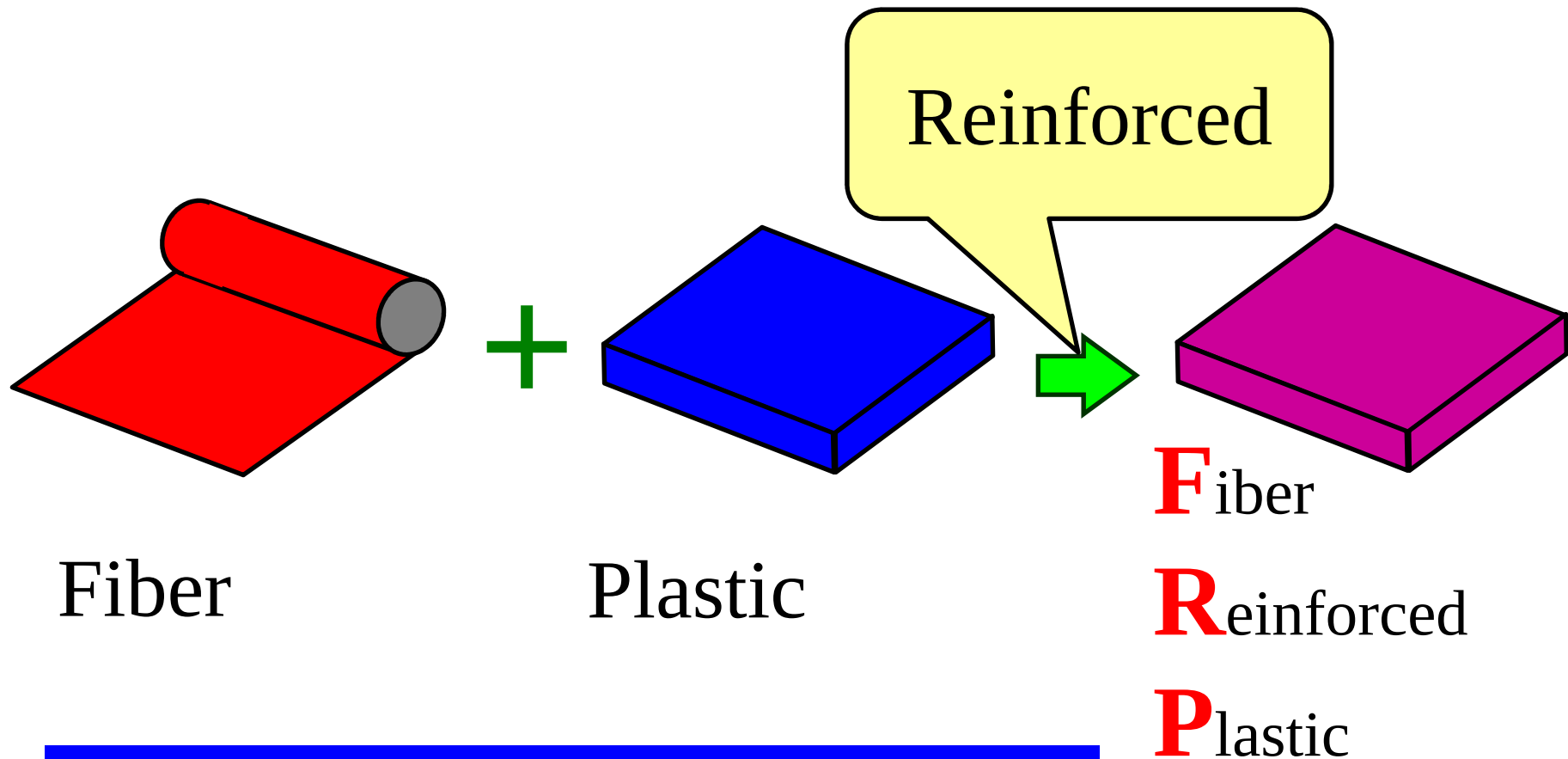


New molding method for FRP TM method

Assistance Thermal expansion
Microcapsule Molding Method

MONOPOST Inc.
Banyoh Chemical Institute LLC

What is FRP?



FRP is one of composite material consisting of fiber and plastic.

The methods of molding for FRP

Wet method and dry method have been established.

Wet method



FRP is produced by impregnating liquid resin into fiber directly.

Hand lay up, Filament winding, RTM, Spray up, Cold press, etc.

Dry
method



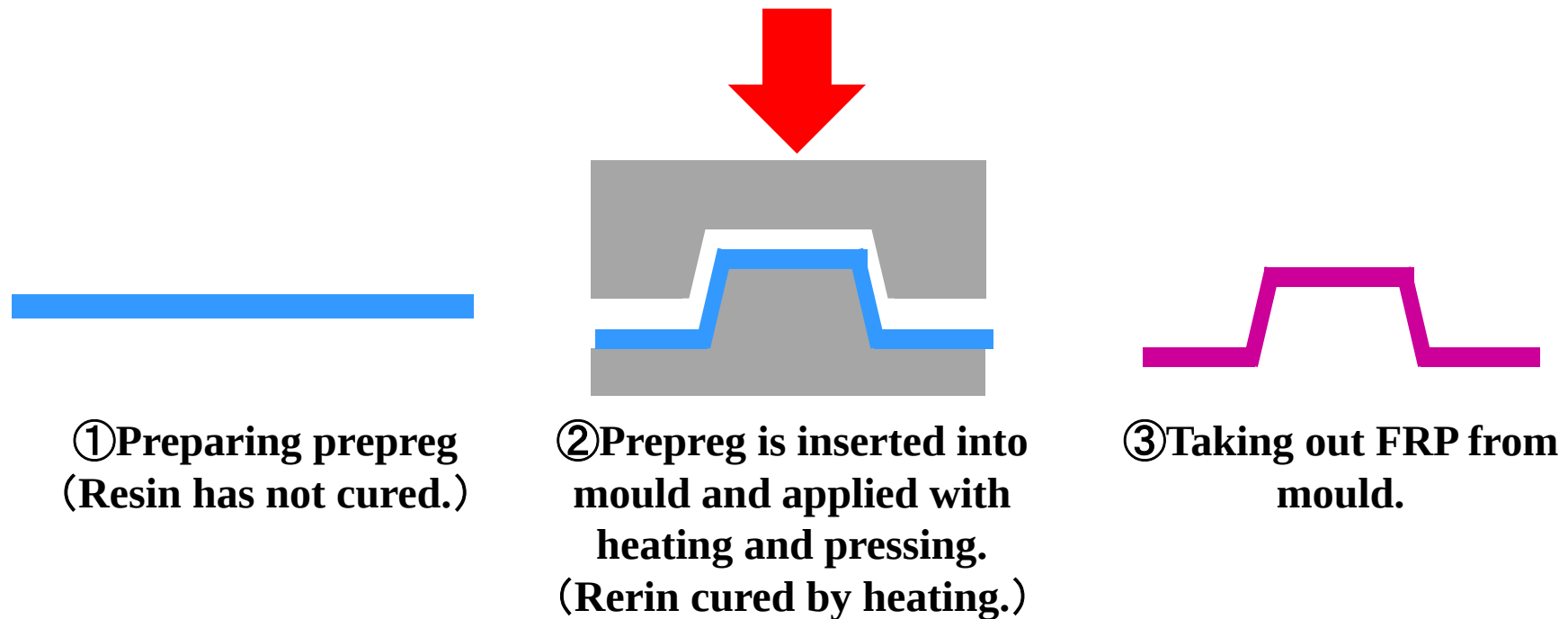
1. Preparing intermediate material which is called prepreg consisting of liquid resin and fiber.

2. FRP is made from prepreg.

3. **High fiber content is attained easily.**

Vaccum back, Autoclave, Sheet winding, SMC, etc.

Press molding by prepreg

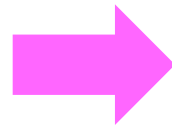


Problems!

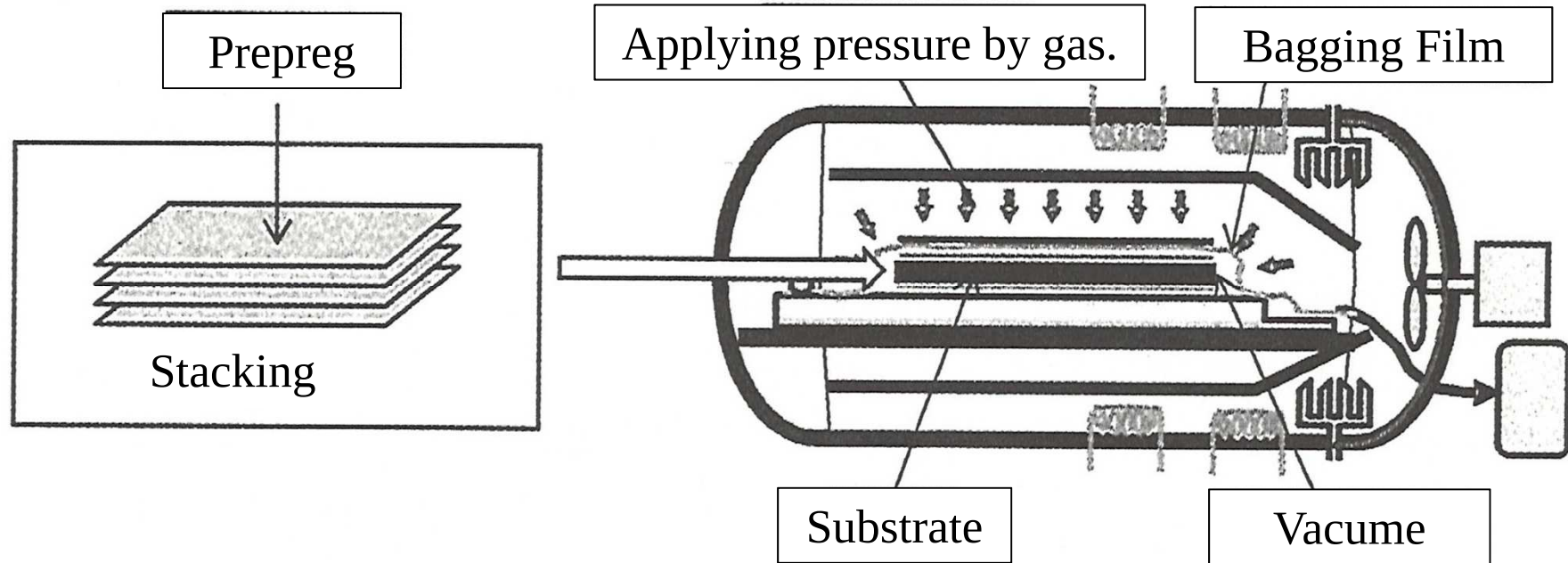
1. This method is not able to apply for precise molding, because some gap are occurred between prepreg and mould.
2. Some voids are also occurred.

Autoclave method

Pressing by high pressure air or gas.



The power spreads to every corner and good molding can be done.



※平野啓之、熱硬化性CFRPの成形法と材料への要求、ネットワークポリマー、Vol.36、No.1、2015、p.38-46

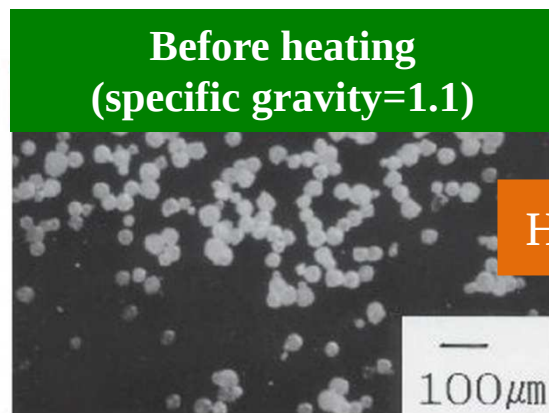
The problem of Autoclave method



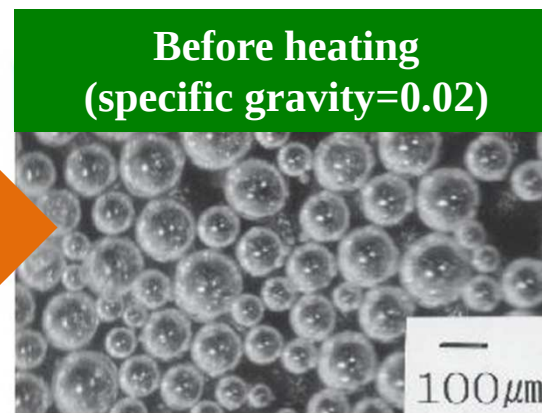
※羽生田製作所HPより

**The equipment is high expensive.
The equipment inside is too small.**

Thermal expandable microcapsule!

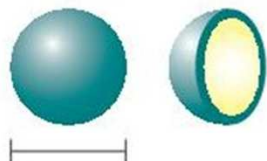


Heating



Chainging of outer daimeter
3-5 times
Thickness of shell (before forming)
about 3-15μm
Thickness of shell (after forming)
0.1-0.5μm
Themperature at starting forming
about 90-210℃
Temperature at max forming
about 125-250℃

Shell=Thermoplastics

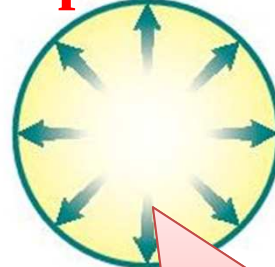


About 15-50μm

Internal=Mainly aliphatic hydrocarbons

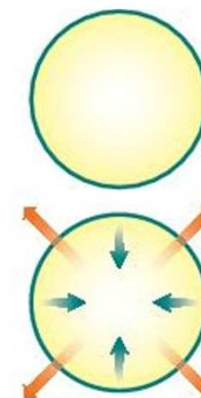
Heating

Expansion!



Cooling

Further Heating



Solidification of the shell stabilizes the shape.

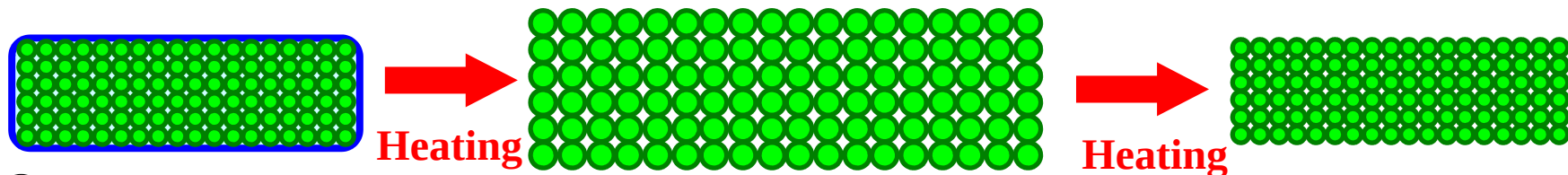
It shrinks due to internal gas leakage.

※イメージ

※クレハマイクロスフェアーズのカatalogより

This power is available for molding!

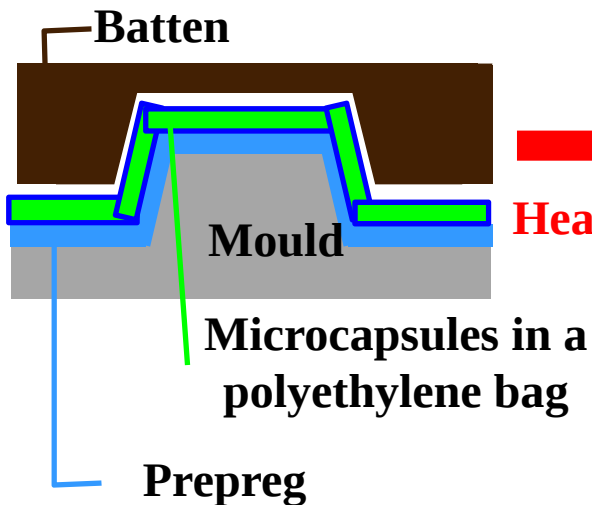
Molding with microcapsule



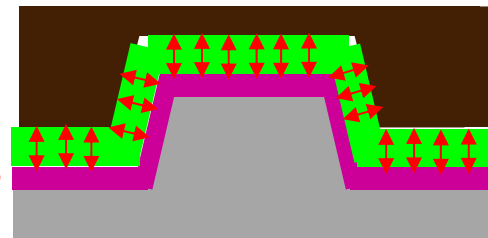
① The microcapsules are placed in a polyethylene bag and sandbag-like.

② When heated, the polyethylene bag melts and the microcapsules expand.

③ Further heating causes the microcapsules to shrink.

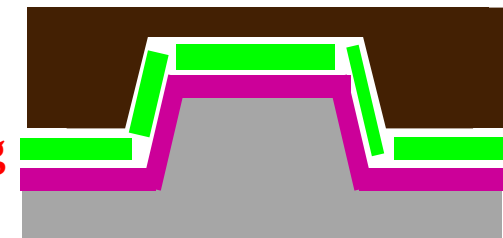


Heating



Molding by expanding of microcapsules

Heating



Shrinkage of the microcapsules facilitates demolding.

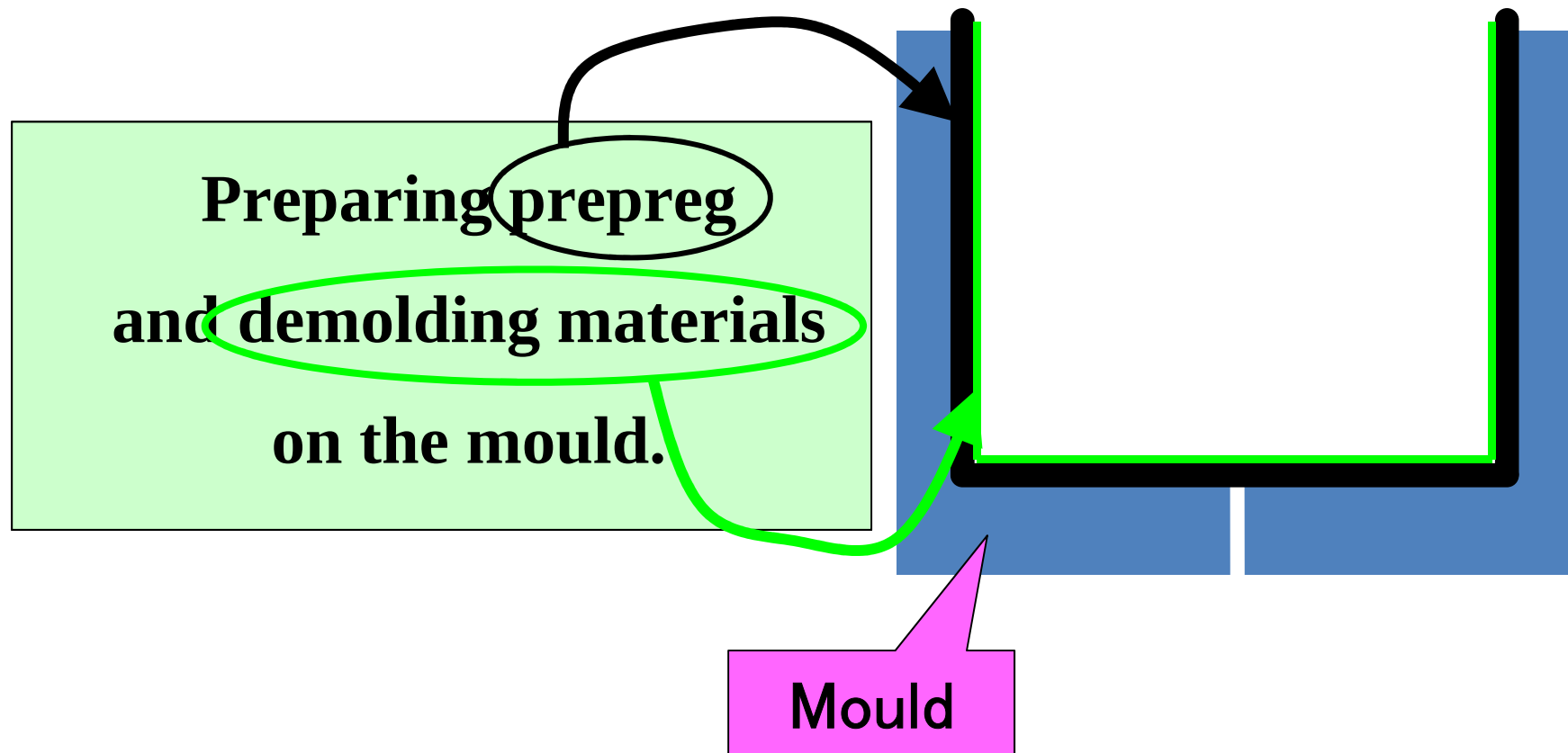
Details of TM method



Configuration feature points (limited items)

- 1. Preparing prepreg and demolding materials on the mould.**
- 2. Preparing heat expandig filler and other powder.**
- 3. Closing the mould.**
- 4. Heating inside of mould and exhausting of the air between prepreg and inside of mould.**
- 5. Microcapsules expand.**
- 6. The molded product has been completed.**

Details of TM method(Process 1)



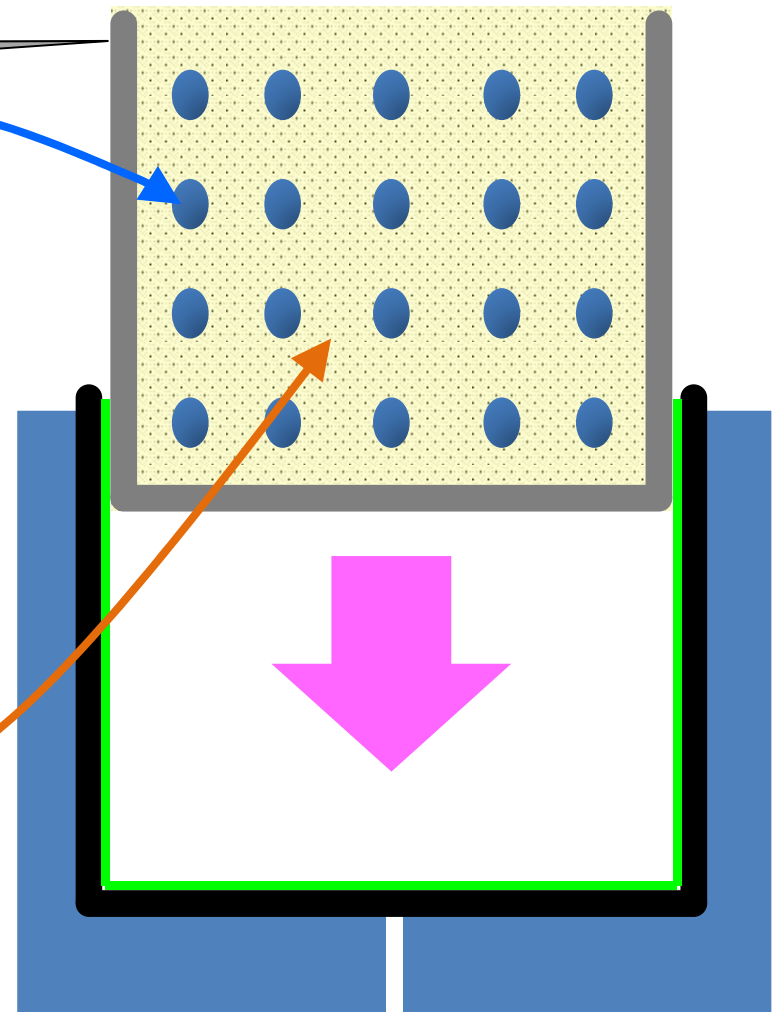
Details of TM method(Process 2)

Polyethylene bag

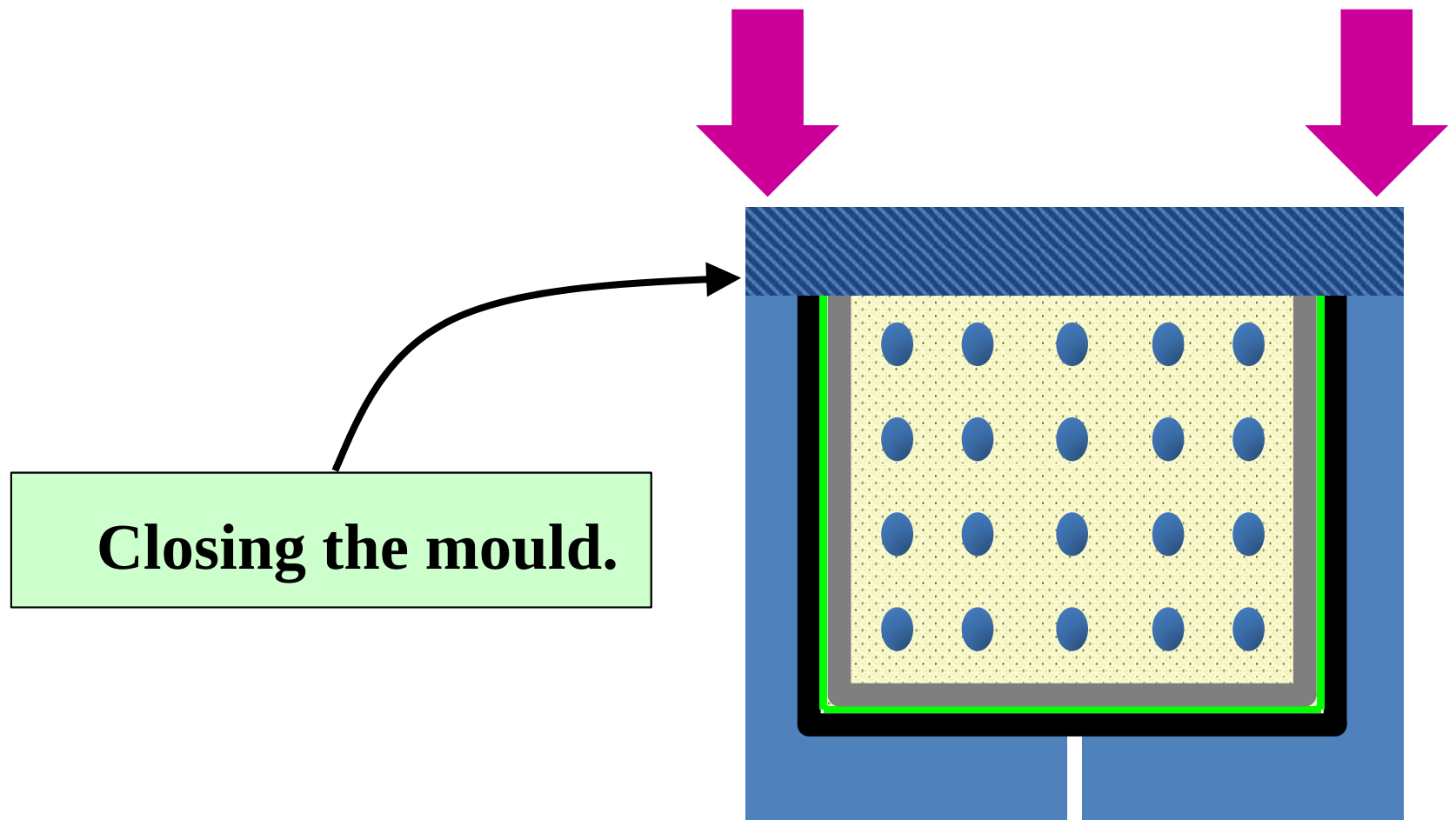
**Heat expandig filler
(Microcapsules)**

+

Other powder

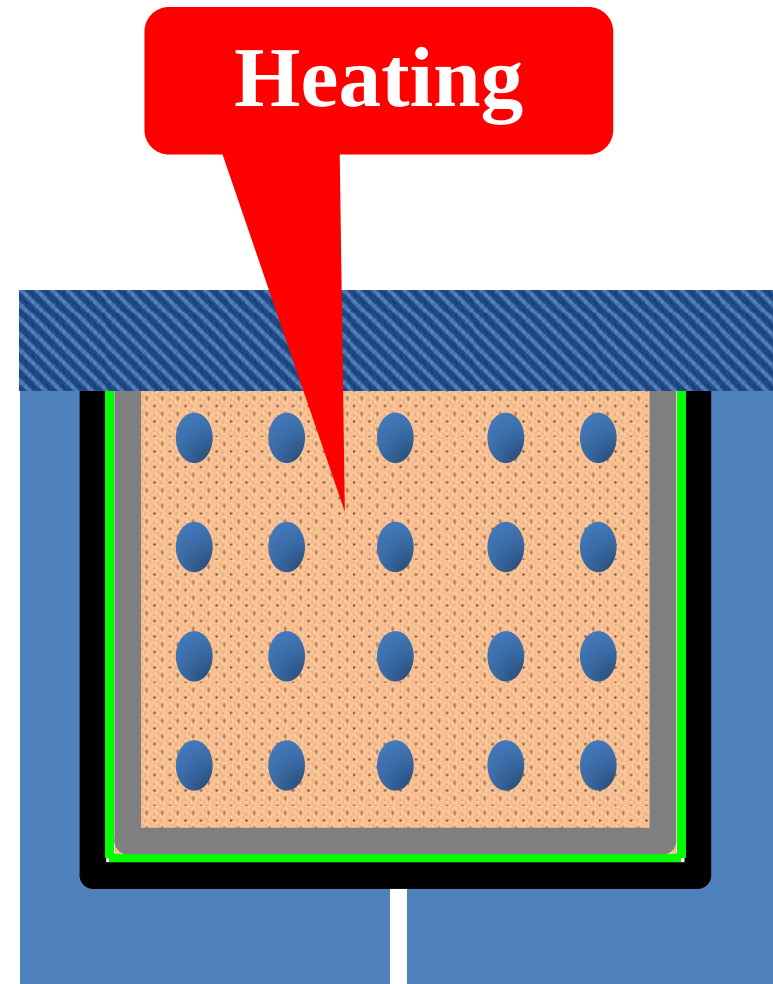


Details of TM method(Process 3)



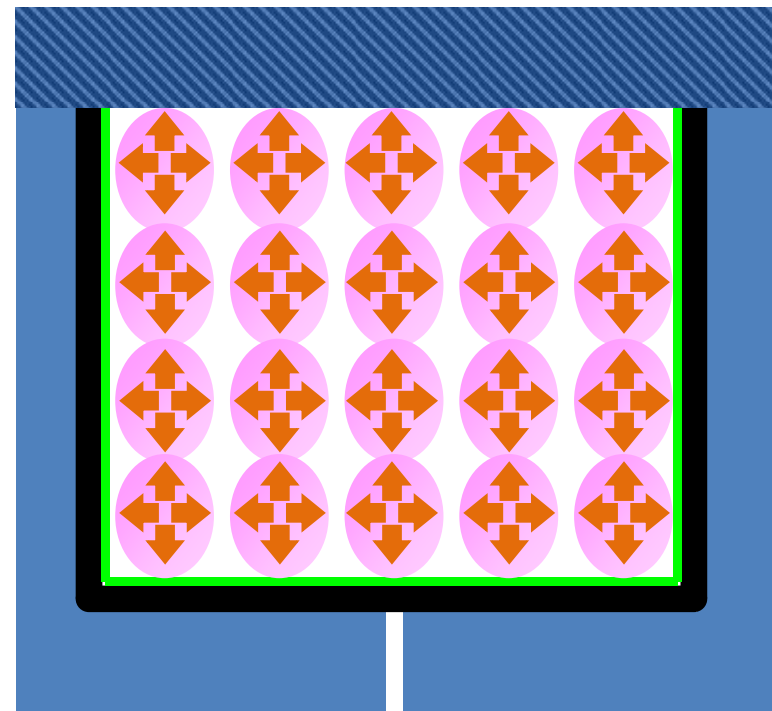
Details of TM method(Process 4)

**Heating inside of mould and
exhausting of the air between
prepreg and inside of mould.**



Details of TM method(Process 5)

Microcapsules expand.



Details of TM method(Process 6)

**The molded product
has been completed.**



TM method (Patent JP-6405433)

JP 6405433 B1 2018.10.17											
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	(11) 特許番号 特許第6405433号 (P6405433)										
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<table border="1"> <tr> <td>(51) Int. Cl.</td> <td>F I</td> </tr> <tr> <td>B 2 9 C 43/18 (2006.01)</td> <td>B 2 9 C 43/18</td> </tr> <tr> <td>B 2 9 C 70/40 (2006.01)</td> <td>B 2 9 C 70/40</td> </tr> <tr> <td>B 2 9 C 44/00 (2006.01)</td> <td>B 2 9 C 44/00 C</td> </tr> <tr> <td>C 0 8 J 9/32 (2006.01)</td> <td>C 0 8 J 9/32 C E P</td> </tr> </table>		(51) Int. Cl.	F I	B 2 9 C 43/18 (2006.01)	B 2 9 C 43/18	B 2 9 C 70/40 (2006.01)	B 2 9 C 70/40	B 2 9 C 44/00 (2006.01)	B 2 9 C 44/00 C	C 0 8 J 9/32 (2006.01)	C 0 8 J 9/32 C E P
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(22) 出願日 平成29年10月11日(2017.10.11)	(74) 代理人 100068663 弁理士 松波 祥文										
審査請求日 平成30年2月14日(2018.2.14)	(72) 発明者 鳥山 倫博 静岡県田方郡函南町仁田810-1 株式会 社MONOPOST内										
早期審査対象出願	審査官 越本 秀幸										
最終頁に続く											

(54) 【発明の名称】 繊維強化樹脂成形品の製造方法

(57) 【特許請求の範囲】

【請求項1】

強化用繊維にマトリックス樹脂を含有させた繊維強化樹脂基材を型の内面に配置し、前記繊維強化樹脂基材が配置された型のコア空間部に熱膨張性マイクロカプセルとそれ以外の粉体とからなる流動性を有する粉体混合物を充填し、型の内面に配置した繊維強化樹脂基材と前記粉体混合物との間に離形材を配置し、型を密閉した後、繊維強化樹脂基材と型の内面との間の空気を排気することにより、該基材と該内面とを密着させ、次いで熱膨張性カプセルの熱膨張開始温度以上、最大膨張温度以下に加熱して、熱膨張性カプセルを膨張させ、前記繊維強化樹脂基材を加熱加圧することを特徴とする繊維強化樹脂成形品の製造方法。

10

【請求項2】

前記粉体混合物における熱膨張性マイクロカプセルの含有量は20～80重量%であることを特徴とする請求項1に記載の繊維強化樹脂成形品の製造方法。

【請求項3】

前記繊維強化樹脂基材が配置された型のコア空間部に、該空間部容積1L当たり200g～600gの前記粉体混合物を充填することを特徴とする請求項1又は2に記載の繊維強化樹脂成形品の製造方法。

【請求項4】

熱膨張性マイクロカプセル以外の粉体は有機物粉体、無機物粉体、チョップドファイバ一、又はそれらの混合物からなることを特徴とする請求項1～3のいずれか一項に記載の

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Advantages of TM method

Using Powder $\Rightarrow$ Complex molding is possible.

Just cover the mold

$\Rightarrow$ Mass production is possible

Unnecessary Autoclave

$\Rightarrow$ There is no limit to the size.

Mould by 3D printer is available.

$\Rightarrow$ It can be molded in the air or space.

Examosles①



Olympic athlete shoes!

Examples②

