Hitachi Chemical
Working On Wonders

Porous Metal

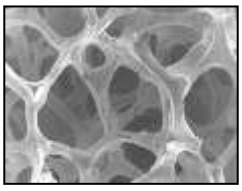
Porous metals with high porosity and thermal conductivity

Technical Points

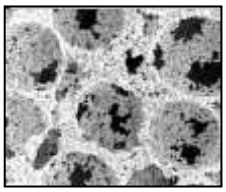
Structure Control — The pore shape, size and skelton can be controlled.

Ultra -low Density — Up to 95% of the porosity.

Various Metals — The porous structure can be formed with various metals. (Al, Cu, Ti, SUS, etc.)



Connected pores

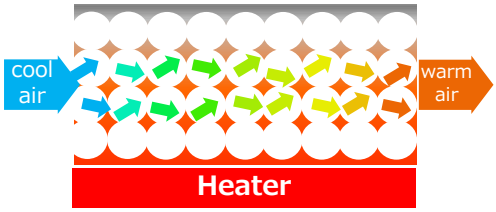


Independent pores

Functions

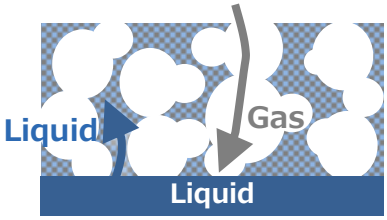
Heat Transportation

High heat transfer by high specific surface area



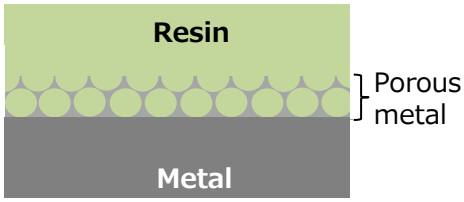
Permeation and Retention of Fluid

The vapor-liquid separation by controlling the hole size.



Heterogeneous Joining

The anchor effect by the three-dimensional structure.



Features

Metal

- High thermal conductivity
  e.g. Al = 236 W/m·K
  Cu = 403 W/m·K
- Electric conductivity
  e.g. Cu = 1.7 μΩ·cm
- High strength
  e.g. Ti = 735 MPa
  (tensile strength)

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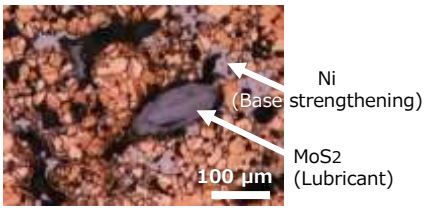
Powder Metallurgy

- High freedom of material selection
  Al : Thermal conductivity
  Cu: Electric conductivity
  Ti : Bio-compatibility
- Alloys and composites are available.
  Metal and non-metal can be combined.



Example:Cu-Sn-Ni-P-MoS2

Application Examples

- **Thermally conductive materials**
  e.g. Heat sink,
  Heat exchanger etc.
- **Carrier for functional materials**
  e.g. Exhaust gas filter
  Fuel cell materials
- **Resin composite components**
  e.g. Engine material of automobile

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NEW

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Copper Paste for Metal Bonding

Thermal Conductivity + Heat Tolerance + Adhesiveness + Electrical Conductivity

Feature 1.

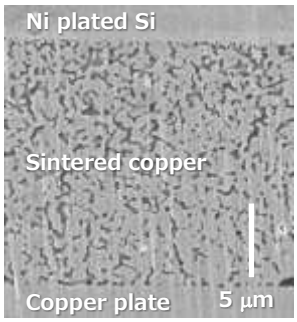
Pressureless Sintering — High heat tolerant reliable metal bonding is available after sintering without compression.

High Thermal Conductivity — Sintered copper shows high thermal conductivity. (>180 W/m·K)

Environmental Friendly — After sintering, bonding layer is composed of copper without lead.

Copper paste

Sintering



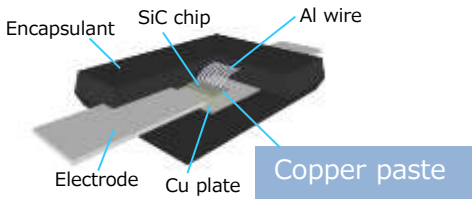
Cross sectional SEM image of copper paste after sintering

Feature 2.

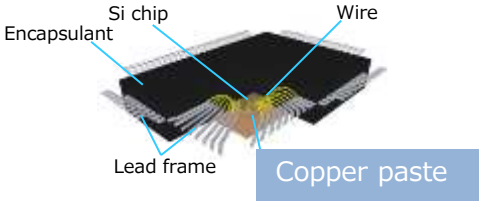
Sintered copper paste shows high thermal conductivity, heat tolerance, and adhesiveness without compression. High reliability bonding is obtained by these.

Item			Unit	Hitachi Chemical Cu paste	Ag paste	High-lead solder	Lead-free solder
Bonding condition	Compression		MPa	-	>10	-	-
	Atmosphere		-	280 ℃、H_2	300 ℃、air	350 ℃、H_2	260 ℃、N_2
Property of sintered compact	Die-shear strength	Cu, Ni	MPa	>40	15	25	>40
		Au, Ag	MPa	>40	>40	25	>40
	Thermal conductivity		W/m·K	>180	>180	24	55
	Working temperature		℃	≦200	≦200	≦150	≦130
	Environmental pollutant		-	-	-	Lead	-

Application Examples



Power device



Logic QFP

- For power device at high temperature operation
  e.g.: SiC, GaN device
- For high exothermic device
  e.g.: LED, Logic IC, Laser diode
- To form metallic copper layer
  e.g.: Copper terminal, Low temperature bonding between metals

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Inorganic-Organic Hybrid Porous Material

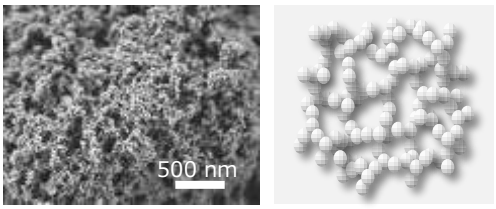
Our material has controllable porous structure at nanoscale to provide excellent thermal insulation and superhydrophobicity

Technical Points

Pore Size Control — Pore size can be controlled (Pore diameter: 10～100 nm)

Maximum Porosity: 95% — Super-lightweight material (Specific gravity: 0.1～0.2 g/cm^3)

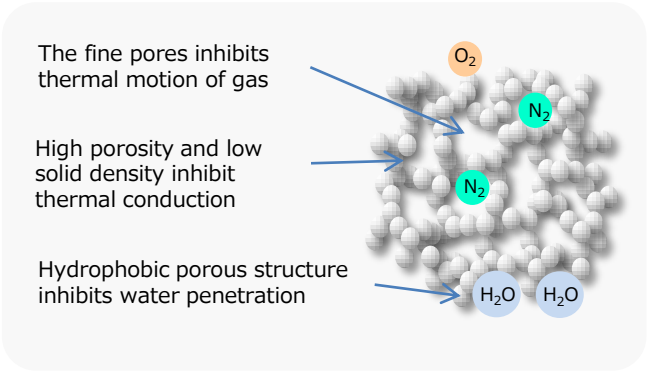
Flexibility — Improvement of brittleness inherent in inorganic material



Inorganic-organic hybrid porous material having a three dimensional network structure

Functions

Thermal Insulation	Low thermal conductivity (Thermal conductivity: 15 ~ 20 mW/m·K)
Super-hydrophobicity	Better than fluoropolymer Coating (Contact angle: >150°)



Features

Porous Structure	Inorganic-Organic Hybrid Material	Composite
・Nanoscale pore size Pore diameter: 10～100 nm ・Lightweight Specific gravity: 0.1～0.2 g/cm^3 ・Superhydrophobicity Derived from porous structure	・Flexibility Applicable to curved surface ・High heat resistance Maximum temperature ~500 °C ・Degradation resistance Weather resistance, Corrosion resistance	・Coating on substrate Coatable on various substrates ・Composite sheet Combinable with non-woven

Application Examples

- Thermal insulator for high temperature (～500 °C)
- Superhydrophobic coating and sheet

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NEW

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Transparent Thermally Stable Polymer

We have developed polymers that exhibit transparency, thermal stability, and optical isotropy, simultaneously.

Technical Points & Functions

Thermal Stability

The polymers maintain the transparency (yellowness index ≦ 1) in a high temperature atmosphere (e.g. 300 ℃ for 10 min).

Transparency Low Birefringence

The refractive index (n) of the material is uniform in all direction (birefringence, $\Delta n \leqq 0.001$). Therefore, they show high visibility.

Control of Modulus

The modulus can be tuned between 1 GPa (as that of soft polyethylenes) and 7 GPa (as that of hard polyimides).

Appearance of the polymer film

Result of the high temperature storage test as polymer samples coated on glass

Item	Our Polymer	Acrylic Polymer
Initial		
After thermal exposure (for 1 h at 250 ℃)		
Yellowness Index	1.0	4.6

Features

Optical Properties		Thermal Stability		Control of Modulus
・Suitable for applications requiring transparency in visible region ・Coatable or film-formable without optical correction	×	Suitable for products fabricated in the high-temperature process	×	Coatable on various substrates such as plastics or glass by adjusting the modulus

Application Examples

- Transparent materials or hard-coatings for displays
- An alternative material to glass, or plastic lenses
- Substrates for micro-fluidic devices

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NEW

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Transparent Tough Polymer

We developed shape recovery tough polymers with high elongation property.

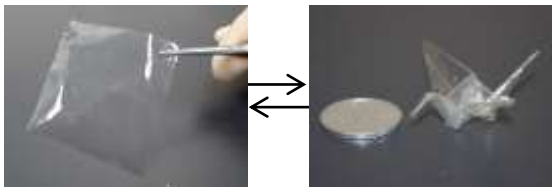
Technical Points

Designing Elastic Modulus

Elastic modulus can be controlled from 0.5 MPa to 1000 MPa.
High viscous soft polymer, and non-fragile rigid polymer are designable.

Transparent High Flexibility

Achieve high bendability without whitening.



180° bending without creasing is possible.

Functions

Tough for Distortion

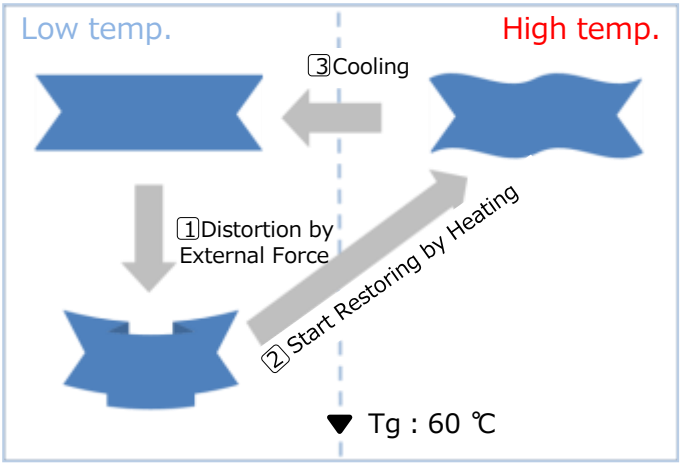
High Modulus High Elongation Type
Elastic Modulus 1000 MPa
Breaking Elongation 500 %

Low Modulus High Strength Type
Elastic Modulus 10 MPa
Breaking Strength 20 MPa

*200 μm thickness film

Shape Reverse Property

Mechanical Distortion at R.T. →1
Restoring to Original Shape starts by Heating →2
Perfect Restoration by Cooling →3



Features

Polyacrylate	Unique Crosslinking Polymer
・Transparent : Visible Light Transmittance ≧ 90 % (100 μm thickness film)	・Stress Relaxation : Low Modulus Type
・Chemical Resistance : HCl, NaOH (10 %aq r.t. 24 h)	・Toughness : High Modulus Type
・Control of Elastic Modulus : 0.5～1000 MPa	・High Bendability : Applicable for Curved-surface Objects (High Modulus Type , Low Modulus Type)
・Easily-Shaping : Arbitrary shape (Film, Fiber, etc.) is applicable.	・Excellent Workability : Powder Free in Cutting Work
・Easy Coloring	

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Application Examples

- Shock Absorbing Material
- Film Protector
- Coating

Collaboration with Prof. Bungo Ochiai, Department of Chemistry and Chemical Engineering, YAMAGATA University

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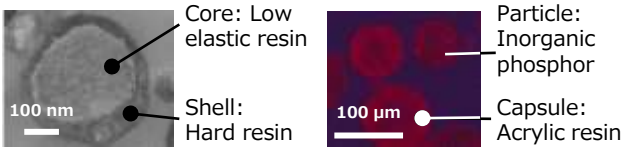
Composite Particle

Plus alpha function to fine particles by using multiple material.

Feature 1.

We provide a unique variety of functional composite particles by using the resin technologies accumulated over many years.

Particle size	0.1 ～ 500 μm
Structure	Core-shell, Capsule
Material	Resin + Inorganic, Resin + Resin



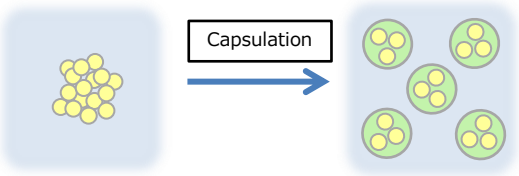
Core-Shell　　Capsule

Feature 2.

Make particles easier to use

e.g. High dispersion particle

The high dispersibility is obtained by using our technology.
e.g. Resin + Inorganic material

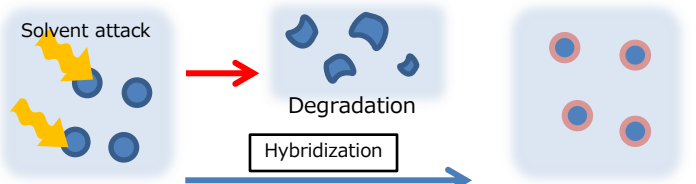


Aggregation　　Dispersion

Meet for your needs by hybridization

e.g. High solvent resistance particle

Both low-modulus and good solvent resistance are achieved by utilizing the solvent resistance of hard resin.
e.g. Low elastic resin + Hard resin



Poor stability　　Long-life stability

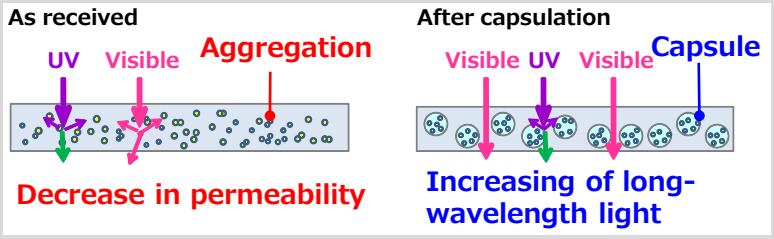
Example of Production

WCP: Wavelength Conversion Particle (Product name: LUMEPARTE)

Satisfy dispersibility and transparency features by capsulation of phosphor with acrylic resin coat

- Example of application
  - Solution of high efficiency PV -

WCP can convert ultra-violet into long-wavelength light



Application Examples

- Color tuning and refractive index adjustment for lighting, optical instrument parts, etc.
- Highly dispersed functional filler for controlling viscosity, elastic modulus, etc.

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