

# Antibacterial material for plastics

Amenity Materials Group, Advanced Materials Business Division

## 1. Introduction

Our company manufactures and markets inorganic silver-based antibacterial materials to be used for glazing sanitary ware, tile, enamel ware, tableware, etc. Now, we have developed inorganic silver antibacterial materials for resins based on the same technology.

MCUT50, introduced below, is an antibacterial material for resins with the antibacterial silver ions melted and dispersed in glass. The silver ions are dispersed stably using the company's proprietary technology that we developed originally for antibacterial materials for glazing.

## 2. Properties

MCUT50 has the following properties:

Item	Property
Appearance	White powder
Average grain size	2.3 $\mu\text{m}$
Specific gravity	2.5
Volume density	0.37 $\text{g}/\text{cm}^3$

## 3. Main Features

MCUT50 consists of white powders obtained by mixing and dissolving glass, silver salts, etc., and crushing the mixture. The grain size is 2.3 $\mu\text{m}$  average and 10 $\mu\text{m}$  maximum for standard grade. The maximum size can be lowered to less than 6 $\mu\text{m}$  to suit a specific need.

MCUT50 has antibacterial effect in a wide range of application. It has the following features in addition to safety of use:

- 1) Lasting antibacterial effect  
Silver is dispersed uniformly in solubility-suppressed glass substrate, and released only very slowly so that the antibacterial effect is maintained over a long period.

- 2) Lasting resin transparency

The whitening by the addition of antibacterial material is kept to the minimum because resin and the antibacterial material have similar refractive indexes when used with glass. This means the original transparency of the resin is maintained over time.

- 3) No water pickup

The antibacterial material content remains low because the glass substrate does not absorb water. This prevents change of properties due to polyester hydrolysis when the material is added to polyester resins.

- 4) High thermal resistance

The antibacterial material consists of inorganic matters and does not melt, decompose or volatilize in temperatures up to around 500°C. This means the material can be added to polyester resins having high melting point without affecting the antibacterial effect.

- 5) High performance from a low additive ratio to resin  
Practical antibacterial effect is available at around 0.5% additive ratio to resin, compared to about 1% with the conventional inorganic silver counterparts.
- 6) High color fastness against UV rays and chemicals  
MCUT50 has high color fastness compared to the conventional silver zeolite-based antibacterial materials.

## 4. Comparison with Conventional Antibacterial Materials

MCUT50 has the following advantages over the conventional organic antibacterial materials and inorganic silver-based antibacterial materials:

- (1) Advantages over organic antibacterial materials
  - 1) Lasting effect (solubility-suppressed glass)
  - 2) Thermal resistance (inorganic composition)
  - 3) UV resistance (stable dispersion in glass)

- (2) Advantages over inorganic silver-based antibacterial materials
- 1) Transparency (proximity of refractive index to resins)
  - 2) Water pickup (glass does not absorb water)
  - 3) Cost saving (low additive ratio and pricing)

## 5. Use

(Resins)

Polyolefin resins (polypropylene resins, polyethylene resins, etc.), BS resins, polyester resins, polystyrene resins, acrylic resins, etc.

(Style of processing)

Moldings, fibers, films

(Purposes)

Daily goods, home appliances, textile, clothing, building materials, etc.

## 6. Typical Effects

Polypropylene resins to which MCUT50 is added present excellent antibacterial performance, color fastness, and other properties. Antibacterial, color fastness, coloring and other tests with polypropylene resin plates with MCUT50 additive ratios of 0.5%, 0.8%, and 1.0%, prepared from a 10% master batch, provided only good results.

### 1) Antibacterial effect test results

Table 1 Antibacterial activity test results

Bacteria	Coliform bacilli
Initial bacteria count	$2.2 \times 10^5$
Reference bacteria count	$3.4 \times 10^6$
Blank	$4.1 \times 10^6$
0.5% additive PP resin	1 0 >
0.8% additive PP resin	1 0 >
1.0% additive PP resin	1 0 >
Competitor A's product (0.5%)	$2.1 \times 10^3$
Competitor A's product (1.0%)	1 0 >

Result : Bacilli were almost entirely extinguished on polypropylene resin with MCUT50 content of only 0.5%. This endorses excellent antibacterial performance of the material.

### 2) UV rays color fastness test results

Table 2 Color fastness test results with UV rays

	Color before UV irradiation			Color difference $\Delta E$
	$L_0$	$a_0$	$b_0$	
Blank	64.48	-1.12	-3.27	1.4
0.5% antibacterial PP resin	68.21	-0.79	-2.06	1.4
0.8% antibacterial PP resin	67.94	-0.87	-1.50	1.4

Result : Samples were subjected to black light irradiation for 6 weeks, and the surface colors before and after irradiation were compared. No significant difference was noted from the blank sample suggesting that discoloration was only minimal.

### 3) Chemical color fastness test results

Table 3 Color fastness test results with 5% NaCl

	Color before immersion			Color difference $\Delta E$
	$L_0$	$a_0$	$b_0$	
Blank	64.20	-1.18	-3.47	0.3
0.5% antibacterial PP resin	68.48	-0.70	-2.02	0.1
0.8% antibacterial PP resin	67.98	-0.90	-1.56	0.6

Result : Samples were immersed in 5% NaCl for 2 weeks, and the surface colors before and after immersion were compared. The color difference of the 0.5% antibacterial PP resin was the same as the blank. No significant discoloration was noted with the 0.8% antibacterial resin sample.

Table 4 Color fastness test results with 99% ethanol

	Color before immersion			Color difference $\Delta E$
	$L_0$	$a_0$	$b_0$	
Blank	64.35	-1.20	-3.48	0.2
0.5% antibacterial PP resin	68.36	-0.79	-2.04	0.2
0.8% antibacterial PP resin	68.03	-0.84	-1.50	0.4

Result : Samples were immersed in 99% ethanol for 2 weeks, and the surface colors before and after immersion were compared. The color difference of the 0.5% antibacterial PP resin was the same as the blank. No significant discoloration was noted with the 0.8% antibacterial resin sample.

### 4) Color resistance test results

Table 5 Color resistance test results

	Blank			Sample			Color difference $\Delta E$
	$L_0$	$a_0$	$b_0$	L	a	b	
0.5% antibacterial PP resin	64.35	-1.20	-3.48	68.22	-0.86	-2.31	4.1
0.8% antibacterial PP resin				68.17	-0.72	-1.96	4.1
Competitor B's product (1.0%)	52.54	-0.94	-2.33	73.25	-0.53	-3.21	20.7
Competitor B's product (0.3%)	24.00	0.00	-4.20	50.40	0.20	-9.10	26.9

\* Competitor B's samples represent MCUT50 applied to PP resins of different types.

Result : A comparison of coloring resistance of polypropylene resin samples with 0.5% and 0.5% MCUT50 additives with that of the blank sample equally led to a color difference  $\Delta E$  of 4.1 due to the increased lightness. However, the difference was nearly negligible in visual inspection of the 0.8% sample.