

Biocidal additives with **silver nanoparticles** for thermoplastic and chemically cured polymers

## POLYDEF Ag+ PA6

### PRODUCT DATA SHEET

POLYDEF Ag+ PA6 is a concentrated masterbatch formulated from silver nanoparticles (Ag) designed for PA-based plastics that adds bactericidal properties to the finished polymer elements.

The presence of nanosilver in the protected polymer ensures a biocidal effect by inhibiting the metabolic pathways of microorganisms, contributing to the elimination of sources of unpleasant smells and the extension of the lifetime of the material. The additive is environmentally friendly, does not affect the physical properties of the polymers and does not cause degradation of the protected material. The component provides long-lasting microbiological protection (microbiological efficacy of  $\geq 99.98\%$ ), as well as enhances the safety and attractiveness of the product. The nano additive is also very stable at high temperatures and in high humidity compared to traditionally used biocides.

#### General information

Polydef Ag+ PA6 is added to the finished product during manufacture. The granules provide antimicrobial properties and should not affect the basic colour or surface finish of the product. The active substances do not degrade or leach. The additive is designed to exhibit constant activity throughout the product life cycle.

#### Recommended dosage

For microbial protection, it is recommended to apply a dosage of 2-6 wt.% relative to the weight of the finished polymer composite. It is advisable to validate the antimicrobial additive prior to product launch.

#### Test procedure

The analysis is a quantitative test designed to assess the performance of antimicrobial properties. Test samples are incubated with a bacterial suspension for 24 hours at 37°C. The average number of viable bacterial cells and the percentage reduction of the selected microorganism are then calculated.

#### Microbiological efficacy

Microbiological efficacy Microbiological properties were subjected to testing in accordance with ISO 22196 *Measurement of antibacterial activity on plastics and other non-porous surfaces*, against the following microorganisms:

- Escherichia coli ATCC 8739
- Staphylococcus aureus ATCC 6538

The reduction efficacy of more than 90% has been confirmed.

#### Storage

The granules have been developed in a manner that ensures the highest stability during storage and use.

Be aware that silver-containing materials may be sensitive to light and electromagnetic fields. Insufficiently mixed product may cause discolouration in the finished goods, which is why it is the responsibility of the manufacturer of the final component to fully assess it under normal conditions of use.

#### Before use

It is important, as with all chemicals, to read the product data sheet before use.

Before applying the product, always ensure that you have the latest information. For more information, contact us at [kontakt@smartnanotech.com.pl](mailto:kontakt@smartnanotech.com.pl).

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PHYSICAL PROPERTIES			
Parameter	Standard	Value	Unit
Density	ISO 1183	1.14	g/cm <sup>3</sup>
Melt Volume-flow Rate (MVR)	ISO 1133	120	cm <sup>3</sup> /10 min
Moisture absorption	ISO 62	3	%
Water absorption to saturation	ISO 62	9.5	%
Processing shrinkage	ISO 294-4	1.4 / 1.4	%
MECHANICAL PROPERTIES			
Parameter	Standard	Value	Unit
Yield point	ISO 527-1,-2	78	MPa
Elongation at break	ISO 527-1,-2	<50	%
Modulus of elasticity when stretched	ISO 527-1,-2	2800	MPa
Bending stress	ISO 178	82	MPa
Flexural modulus when bended	ISO 178	2400	MPa
Unnotched Charpy impact strength	ISO 179-1	5	kJ/m <sup>2</sup>
Notched Charpy impact strength (-30°C)	ISO 179-1	3	kJ/m <sup>2</sup>
THERMAL PROPERTIES			
Parameter	Standard	Value	Unit
Melting point	ISO 11357-1-3	221	°C
Vicat softening point	ISO 306	195	°C
Deflection temperature under load	ISO 75-1,-2	60	°C
Coefficient of linear thermal expansion II	ISO 11359-1/-2	1.1 / 1.2	E-4/°C



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## REPORT

### Evaluation of the biocidal properties of PA6-based polymers

#### Materials and methods:

The experiment was performed according to ISO 22196: Plastic - Measurement of antibacterial activity on plastics and other non-porous surfaces.

#### Test microorganisms:

- *Escherichia coli* (ATCC 8739)
- *Staphylococcus aureus* (ATCC 6538)

#### Number of viable bacteria in the inoculum:

- *Escherichia coli* –  $7.5 \times 10^5$  cfu·cm<sup>-3</sup>
- *Staphylococcus aureus* –  $7.5 \times 10^5$  cfu·cm<sup>-3</sup>

#### Contact time:

- 24 hours

**Table 1** Number of viable bacteria on control and test samples.

<i>Escherichia coli</i>						
Assessed parameter	Control sample immediately after inoculation	Control sample after 24 h	Sample with 2 wt.% after 24 h	Sample with 4 wt.% after 24 h	Sample with 6 wt.% after 24 h	Sample with 8 wt.% after 24 h
Average number of viable bacteria cells [cfu·cm <sup>-2</sup> ]	2.1×10 <sup>4</sup>	5.6×10 <sup>5</sup>	0	0	0	0
Average of the common logarithm of the number of viable bacterial cells	4.3	5.8	0	0	0	0
<i>Staphylococcus aureus</i>						
Assessed parameter	Control sample immediately after inoculation	Control sample after 24 h	Sample with 2 wt.% after 24 h	Sample with 4 wt.% after 24 h	Sample with 6 wt.% after 24 h	Sample with 8 wt.% after 24 h
Average number of viable bacteria cells [cfu·cm <sup>-2</sup> ]	4.0×10 <sup>4</sup>	3.2×10 <sup>4</sup>	0	0	0	0
Average of the common logarithm of the number of viable bacterial cells	4.6	4.5	0	0	0	0

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**Table 2** Antimicrobial activity and reduction of bacteria on tested surfaces.

Dosage	<i>E. coli</i>		<i>S. aureus</i>	
	Antimicrobial activity [log]	Reduction in number of bacteria [%]	Antimicrobial activity [log]	Reduction in number of bacteria [%]
2 wt.%	5.80	100.00	4.60	100.00
4 wt.%	5.80	100.00	4.60	100.00
6 wt.%	5.80	100.00	4.60	100.00
8 wt.%	5.80	100.00	4.60	100.00

**Graph 1.** Antimicrobial activity and reduction of bacteria on tested surfaces.

