

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

## POLYDEF Ag+ PP

### PRODUCT DATA SHEET

**POLYDEF Ag+ PP is a concentrated masterbatch formulated from silver nanoparticles (Ag) designed for HDPE and PP-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+ PP 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).

*The information presented in this document is provided to the best of our knowledge and with due diligence to ensure that it is accurate and up-to-date. Smart Nanotechnologies S.A. shall not be liable for any damages arising directly or indirectly from the use of the information contained herein. The document is issued subject to the user determining the safety and suitability of the product before use. Since regulations are country-specific, local information should be consulted before marketing the product.*

## POLYDEF Ag+ PP

### POLYMER MATRIX DATA SHEET



POLYDEF Ag+ PP is a concentrated masterbatch formulated from silver nanoparticles (Ag) designed for HDPE and PP-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.

PHYSICAL PROPERTIES			
Parameter	Standard	Value	Unit
Density	PN EN ISO 1183	0.90	g/cm <sup>3</sup>
Melt Flow Rate (MFR) (230°C/2.16 kg)	PN EN ISO 1133	53	g/10 min
Melt Volume-flow Rate (230°C/2.16 kg)	PN EN ISO 1133	72	cm <sup>3</sup> /10min
MECHANICAL PROPERTIES			
Parameter	Standard	Value	Unit
Modulus of rigidity when stretched	ISO 527-1, -2	1600	MPa
Yield point when stretched	ISO 527-1, -2	35	MPa
Elongation at break	ISO 527-1, -2 a	50	%
Elongation at yield point	ISO 527-1, -2	8	%
THERMAL PROPERTIES			
Parameter	Standard	Value	Unit
Vicat softening point (A50; 500C/h 10N)	PN EN ISO 306	95	°C
(B50 (50°C/h 50N))		154	
Temperature of deflection under load B (0.45 MPa), specimen not heated	PN EN ISO 75B-1	95	°C



## REPORT

### Evaluation of the biocidal properties of PP-based composites

#### 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> ]	$3.5 \times 10^4$	$2.0 \times 10^6$	$1.1 \times 10^3$	0	0	0
Average of the common logarithm of the number of viable bacterial cells	4.5	6.3	3.0	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> ]	$3.4 \times 10^4$	$2.0 \times 10^5$	$2.3 \times 10^2$	0	$8.6 \times 10^2$	$2.5 \times 10^2$
Average of the common logarithm of the number of viable bacterial cells	4.5	5.3	2.4	0	2.9	2.4



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

**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.%	3.3	99.9	2.9	99.8
4 wt.%	6.3	100	5.3	100
6 wt.%	6.3	100	2.4	99.6
8 wt.%	6.3	100	2.9	99.8

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

