

TECHNICAL DATA SHEET

ABS POLYMER

Acrylonitrile-Butadiene-Styrene Copolymer

MANUFACTURER

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The manufacturer of the original polymer without Graphene material is ELIX Polymers, S.L.

BIOCOMPABILITY

The original polymer meets with the biocompatibility USP Class VI plastics and ISO 10993-1 requirements up to 30 days in human contact. Additionally, the polymer is suitable for food contact according to European Regulation EU No. 10/2011 and FDA Regulation 21 CFR.

Tests performed on the polymer: USP Class VI with Histopathology (USP <39>), Physicochemical Test for Plastics (USP <381>), Analysis for Metals (ICP-OES Elemental testing after acid digestion) - metals not detected at the detection limit, Rabbit Pyrogen (ISO 10993-11/ISO 10993-12/ISO IEC 17025/2005) - non-pyrogenic, Systemic Injection (ISO 10993-11/ISO 10993-12/ISO IEC 17025/2005) and Short Term Intramuscular Implantation (ISO 10993-6/ASTM F 981-93) - non-toxic, In Vitro Hemocompatibility (ISO 10993-4), Rabbit blood Hemolysis (ASTM F756-13) - non-hemolytic, Cytotoxicity - MEM Elution (USP <39>/ISO 10993-5/ISO 10993-12) and L929 Neutral Red Uptake (ISO 10993-5/ISO 10993-12) - non-cytotoxic, Sensitization-Kligman Maximisation (ISO 10993-10/ISO 10993-12) - no evidence of sensitization, Intracutaneous Injection (ISO 10993-10/ISO 10993-12/ISO IEC 17025/2005) - negligible irritant, Ames Assay (ISO 10993-3/ISO 10993-12) - non-mutagenic and RoHS compliant.

ANTIMICROBIAL EFFECT

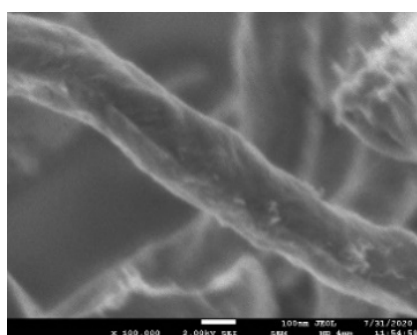
The antimicrobial effect of silver, in a metallic state or through its salts, has been widely demonstrated in various investigations and is currently used in sectors such as health or food, for example, the US Food and Drug Administration (US FDA) approves different uses of this element. The graphene oxide is safe, it has a high purity in terms of contaminants such as sulphates or metals (such as iron or manganese), all of which have concentrations below <0.5%. The graphene oxide (GO) effect is based on the ability of Ag⁺ silver ions to generate reactive oxygen species (ROS) agents such as H₂O₂, OH⁻ and O₂⁻ capable of destroying the respiratory system of microorganisms and specifically attacks the lipid membrane of the coronavirus. The high specific surface area of GO facilitates an attractive interaction to the bacterial membrane with a high degree of contact and allows the silver nanoparticles to release Ag⁺ ions on the bacteria in a localized manner. Recent research shows a synergy in terms of antimicrobial effects resulting from the combination of these nanoparticles with graphene oxide and in vitro evaluations by human skin fibroblast cells including live and dead assay and MTT results show that GO promote cell viability of porous nanofibrous membrane.

Material properties	ABS (Blue)	ABS (White)	NEO ABS (GNF)	DURA ABS (GO)	ABV ABS (GO-AgNp)
Specific Gravity (g/cc)	1,05	1,05	1,12	1,05	1,05
Hardness, Shore D	81,2	81,2	81,3	81,2	81,2
Colour	Blue	White	Black	Blue/Grey	Grey

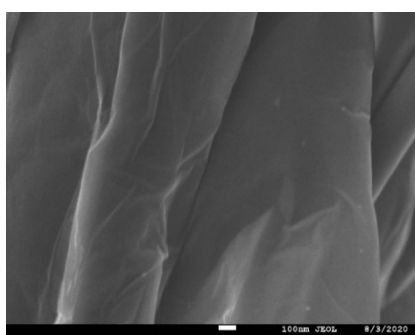
Mechanical properties (ISO Data)	ISO	ABS (original)	NEO ABS (GNF)	DURA ABS (GO)	ABV ABS (GO-AgNp)
Tensile Strength at Yield (MPa)	ISO 527	39,31	41,04	33,03	37,06
Tensile Modulus (Mpa)	ISO 527	2.525	1003,14	861,25	971,09
Elongation at Yield (%)	ISO 527	2,00	2,00	1,95	1,78
Elongation at break	ISO 527	11,21	10,23	4,29	9,67
Flexural modulus (Mpa)	ISO 527	2600	2686,65	2758,85	2627,79
Adhesion between layers 3D Max F (N)		220,24	242	139,65	221,45
Charpy impact strength (kJ/m ²)	ISO 179-1Eu (23°C)	16	16,1	17,7	19,2

Other properties (3D printing)	ISO	ABS (original)	NEO ABS (GNF)	DURA ABS (GO)	ABV ABS (GO-AgNp)
Injection molding-melt temperature (°C)		235-250	235-250	260-300	260-300
Bed temperature (°C)		85-110	90-110	95-110	95-110
Velocity (mm/s)		30-60	30-60	30-60	30-60
Softening temperature, Vicat (°C)		98	99	99	99

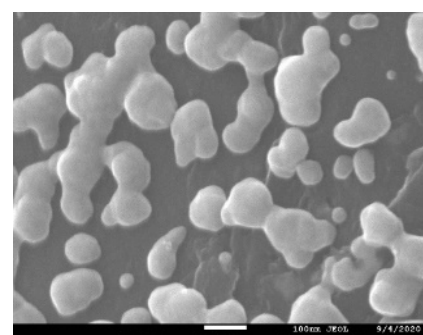
Scanning Electron Microscope (SEM)



Graphene Nanofiber (GNF)



Graphene Oxide (GO)



Graphene Oxide-AgNp

Test performed on 3D printed specimen

Top and bottom layer (mm)	3+3
Intermediate layer (mm)	3
Filling (%)	100%
Tensile Tester UNE EN ISO 527	1BA
Flexural Test Specimen UNE EN ISO 168 (mm)	80x10x4

The values in this data sheet may change depending on printing conditions, part design or environmental conditions.