Redesigning Earth

Technical Data Sheet (TDS) Product Name: biostruct-70-DES

Type

High-strength, bio-based dry powder formulation for large-format additive manufacturing (LFAM)

Application

3D printing of structural components (walls, columns, facades, slabs, architectural forms)

Form

Hot mixed homogeneous dry powder blend with low moisture content (<5%)

Composition

Component	Content (% by weight)	Function
Chitin	35%	Structural reinforcement
Chitosan	35%	Biopolymer binder
Choline Chloride *	15%	DES plasticizer / crosslinker
Citric Acid *	15%	DES plasticizer / crosslinker

*) DES (Deep Eutectic Solvent) plasticizer / crosslinker references:

- Choline chloride: technical / pharma grade, low moisture, crystalline
- Citric acid powder: e.g. Jungbunzlauer Citric Acid Anhydrous, granular grade <200 µm

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Powder Specifications

Property	Chitin	Chitosan
Particle Size	20–80 μm	20–60 μm
Degree of Deacetylation (DDA)	<20%	≥90%
Water Content	<5% (sealed immediately)	<5% (sealed immediately)
Glucan Content	<5%	<5%
Molecular Weight	300–800 kDa	100–400 kDa
Crystallinity Index	>65%	50–65%
Purity (dry basis)	>95%	>95%
Ash Content	<1.5%	<1.5%
Additives	None	None

Material Properties (Processed at 135°C and 50-70 bar)

Property	Value / Range
Bulk Density (dry)	1,200–1,400 kg/m³
Compressive Strength	300–700 MPa
Tensile Strength	200–400 MPa
Flexural Strength	100–300 MPa
Elastic Modulus	10–20 GPa
Thermal Conductivity (λ)	0.2–0.4 W/m·K
Fire Resistance	Moderate to high
Transparency (thin sections)	Translucent to glass-like
Water Resistance	Excellent (dense matrix)
Biodegradability	Yes
Recyclability	Yes (mechanical and compostable)

Annex A – Material Preparation Protocol

1. Raw Materials

- Chitin and Chitosan must meet the above specifications.
- No proteins, calcium carbonate, or residual acids may be present.
- Choline Chloride and Citric Acid must be in dry powder form (food/pharma grade preferred)

2. Milling and Sieving

- Grind and sieve:
  - Chitin: 20–80 µm
  - Chitosan: 20–60 µm
- Screen out agglomerates.

3. Drying

- Dry all components (separately) to <5% (preferably 1%) moisture using:
  - Dehumidified air ovens or vacuum dryers at 60–80°C
- After drying, cool in a dry-air or inert chamber to avoid moisture uptake.

4. Blending

- Separate blend DES Choline Chloride and Citric Acid (50:50) 30% of total mass
- Separate blend Chitin and Chitosan (50:50) 70% of total mass
- Use a high-shear sealed blender or ribbon mixer under dry or inert conditions.
- Blend 15–30 minutes until fully uniform.

5. Hot mixing

- Use for hot mixing:
  - Sigma-blade / Z-blade kneader with heated jacket
  - (or) Internal mixer / torque rheometer (e.g. Haake, Brabender)
  - (or) double-planetary mixer with heated bowl
- Heat (30% of total mass) DES Choline Chloride and Citric Acid at slow/moderate speed at 135°C until fully melted to transparent liquid
- Keep temperature at 135°C and gradually add the blended Chitin and Chitosan powder and continue mixing at slow/moderate speed until the mass is visually homogeneous (no visible powder pockets or DES pools)
- Target processing window: highly viscous, cohesive, non-sticky dough that pulls away from walls and rotates as a single mass