

Structuring mechanism	Example technologies	Commercial maturity	Typical throughput	Key advantages	Key limitations
Shear-induced alignment	HME, Shear Cell, PowerHeater, ShearTex, FlatBooster	High – Medium	75 – 500+ kg/h	Proven technology, scalable, robust, wide range of structures (including whole cuts)	Limited hierarchical structure; scaling up some variants remains challenging
Assembly of preformed fibers	JuicyMarbles, Offbeast	Emerging	Unknown	Enables whole-muscle architecture, marbling, and fiber bundles	Multiple processing steps, high complexity
Additive manufacturing	Depositing, precision depositing, 3D printing, Revo Foods, NovaMeat	Emerging	Low	High design flexibility and spatial control	Low throughput, high costs
Biological structuring	Mycelium fermentation, Chunk Foods, Meati, Libre Foods	Medium	Dependent on fermentation	Naturally fibrous structures	Fermentation capacity and costs
Phase separation and freeze structuring	Freeze structuring, directional freezing, New School Foods	Emerging	Low – Medium	Strong anisotropy and fibrous texture	Batch processing and high freezing costs
Fiber formation	Fiber spinning, Lasso SpinTech, Project Eaden	Emerging	200 kg/day – 450 kg/h reported	Fine fiber formation with minimal thermal damage	Scalability currently remains limited
Layer-building technologies	Laminating, sheeting, stacking (ProFillet, Handtmann-Planteneers)	Medium	1 – 3 metric tons/h possible	Highly scalable, enables layered and multiphase structures	Not yet proven at scale for meat alternatives
Strand-forming technologies	Pasta extrusion, noodle processing, confectionery extrusion	High	High	Continuous processing and high throughput	Requires specific rheological properties in the protein dough
Stretching-based technologies	Surimi processing, mozzarella cooker/stretcher	High (<i>for the original products</i>)	High	Creates highly aligned fiber structures	Matrix-specific functionality is difficult to replicate with plant proteins
Mechanical structuring and shaping	Molding, forming, hot pressing, RevoPortioner	High	High	Simple and affordable	Limited ability to generate intrinsic fibrousness