

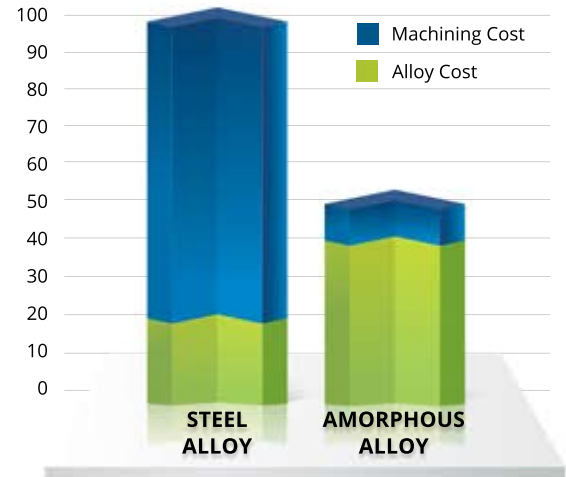
ADVANCED GEAR PRODUCTION

Amorphology's amorphous alloys are changing the manufacturing paradigm. Traditionally, steel and titanium alloys have been difficult to cast well and achieve high strength, hardness, and durability, due to these alloys' high melting temperatures. As a result, companies have generally produced parts from billets of steel requiring significant costs in machining, grinding, and polishing.

Using amorphous metals, also known as bulk metallic glasses (BMGs), Amorphology casts high-resolution net-shape parts, including gears and gear components. Cast amorphous parts display high hardness and wear resistance, are able to operate in unlubricated environments, exhibit high surface finishes, and are corrosion-resistant.

In particular, the casting of BMGs excels for small parts, including small components, or gears with complex geometries, and can be used for other gear components such as bearing races, pins and rollers.

STEEL VERSUS AMORPHOUS ALLOY PRODUCTION COSTS



BMGs ARE PARTICULARLY SUITED TO:

- Planetary gears from 50 microns to one inch in diameter
- Gearboxes
- Strain-wave gears
- Cold, harsh or corrosive environments
- Specialty applications such as food & beverage, medical, biomedical, and pharmaceutical

BMG gears have mechanical properties like a flexible ceramic. They are high in strength, wear resistant, and hold up to extreme cold temperatures. Bulk metallic glass is moldable for reduced component costs per unit, at scale. BMG gears can run unlubricated, making them highly desirable in sanitized or clean-room environments.

Amorphology flips the paradigm of low-cost steel and high-cost machining by reducing machining costs from complex gear production—resulting in up to a 50% total per-part cost reduction in some cases. Casting of BMGs within specific product parameters such as size, volume and thickness, results in final gears that exceed the required specifications of traditional steel versions.

If machining is more than 30% of your part production cost, or is a bottleneck in your production line due to scaling and backlog, labor, CAPEX or even part waste, then BMGs may be your answer. Additionally, if you require specialty materials for applications where steel won't work and titanium is more desirable, BMGs offer a viable, cost-effective solution.



OUR CAPABILITIES

Amorphology is an advanced metals application and characterization company with alloy development and prototyping capabilities across a variety of patented alloys and production methodologies. Our unique materials and manufacturing patents allow us to design and create products requiring little or no machining, and yet offer significantly different properties compared to steel and titanium.

We have in-house capabilities to perform prototyping, casting, alloy development and powder production. In addition, our characterization abilities include powder characterization, oxygen content analysis, hardness testing, microscopy, differential scanning calorimetry and x-ray diffraction.

Our skunkworks approach to coatings and 3D printing of BMG alloys provides a creative solution to traditional methods that have become an excessive cost to your bottom line. Advanced gear production is dependent on a number of critical factors to ensure a quality product. These factors can include high tensile strength, high fatigue endurance limits, low coefficient of friction, and low-cost manufacturability. Historically these criteria have been achieved by using cast iron, steel, ceramics and plastic to produce a wide variety of gears—from planetary to spur, worm to strain-wave.

BENEFIT	BMG'S	STEEL
Single Step Casting	☑	x
Marginal Part Cost	50% cost reduction	\$\$ to \$\$\$\$
Lubrication FREE	☑	x
Rust Resistant	☑	x
Wear Performance	2x	x



WHY AMORPHOLOGY?

We leverage the superior attributes of BMGs, along with advanced proprietary manufacturing strategies, to build a wide variety of gear types that significantly improve operating characteristics. This is accomplished with reduced manufacturing costs and the ability to create advanced geometries. Our gears resist corrosion and can be produced in a single-step manufacturing process—either reducing or eliminating the need for further machining and finishing.

The alloys and manufacturing processes are developed using exclusively licensed technology and intellectual property from the California Institute of Technology (Caltech), as developed by NASA's Jet Propulsion Laboratory (JPL).

BMG parts can be produced using various production methods such as: casting, injection molding, coating and additive manufacturing.

ABOUT US

Amorphology is leading the innovation around advanced materials and manufacturing technology targeted towards improving gears for robotics and other industrial applications. We are changing the paradigm for how gears are manufactured utilizing BMG alloys, metal-matrix composites, and innovative 3D printed metals. We bring a robust and diverse intellectual property portfolio to planetary gears and other components, offering new designs and new manufacturing technologies to a growing market.