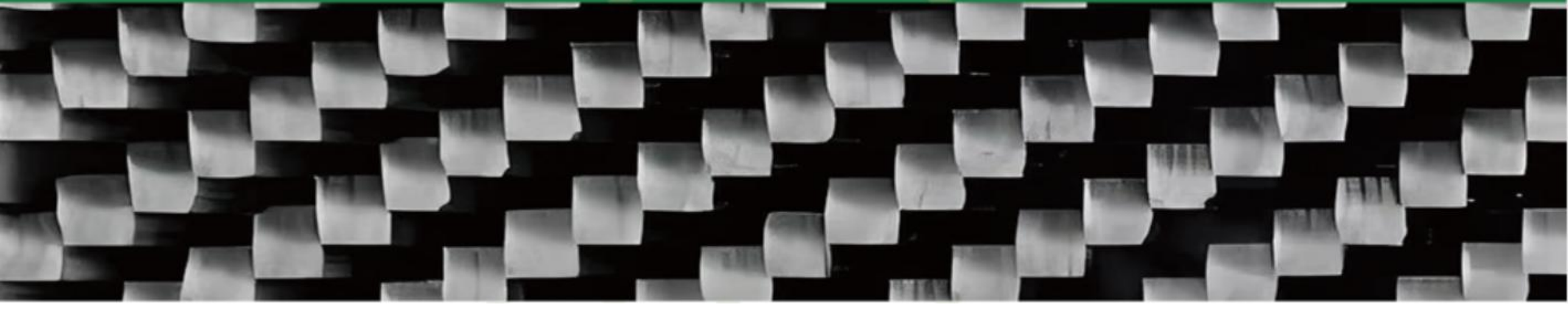
Polygram®



广东宝粒金新材料科技有限公司

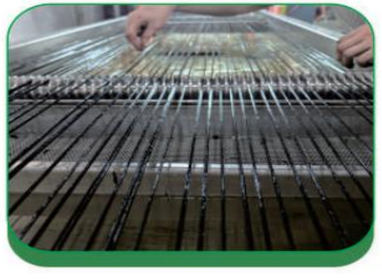
GUANGDONGBAOLIJINNEWMATERIALTECHNOLOGYCO.,LTD

广东宝粒金新材料科技有限公司

我们是一家专注于：热塑性（LFT)长纤维复合材料,导电防静电材料，石墨烯导热材料研发与产品制造的高新技术企业，致力于为客户提供从材料设计、原料生产、模具开发到注塑成型的全流程一站式服务。凭借在高分子改性材料，精密模具制造及复合材料工艺领域的深度积累，我们突破了碳纤维传统高成本、低效率的行业瓶颈，为航空航天、军工、新能源汽车、低空经济、机器人、半导体、运动器材等高端产业提供轻量化、高强度、耐腐蚀的尖端产品解决方案。

We are a high-tech enterprise specialized in the R&D and manufacturing of thermoplastic (LFT) carbon fiber composites, conductive and anti-static materials, and graphene thermal conductive materials. We are committed to providing customers with one-stop full-process services ranging from material design, raw material production, mold development to injection molding.Relying on our profound expertise in polymer modified materials, precision mold manufacturing and composite material processes, we have broken through the traditional industry bottlenecks of high cost and low efficiency associated with carbon fiber. We deliver high-performance product solutions featuring lightweight, high strength and corrosion resistance for high-end industries such as aerospace, military industry, new energy vehicles, low-altitude economy, robotics, semiconductors and sports equipment.



公司服务范围 SCOPE OF SERVICES

Polygram

- **复合材料研发与定制**
  Composite Materials R&D and Customization
- **模具开发与制造**
  Mold Development and Manufacturing
- **注塑成型**
  Injection Molding

CERTIFIED ISO 9001:2015 COMPANY

RoHS COMPLIANT

International Automotive Task Force IATF 16949:2016

SYSTEM CERTIFICATION ISO 9001:2000 SGS

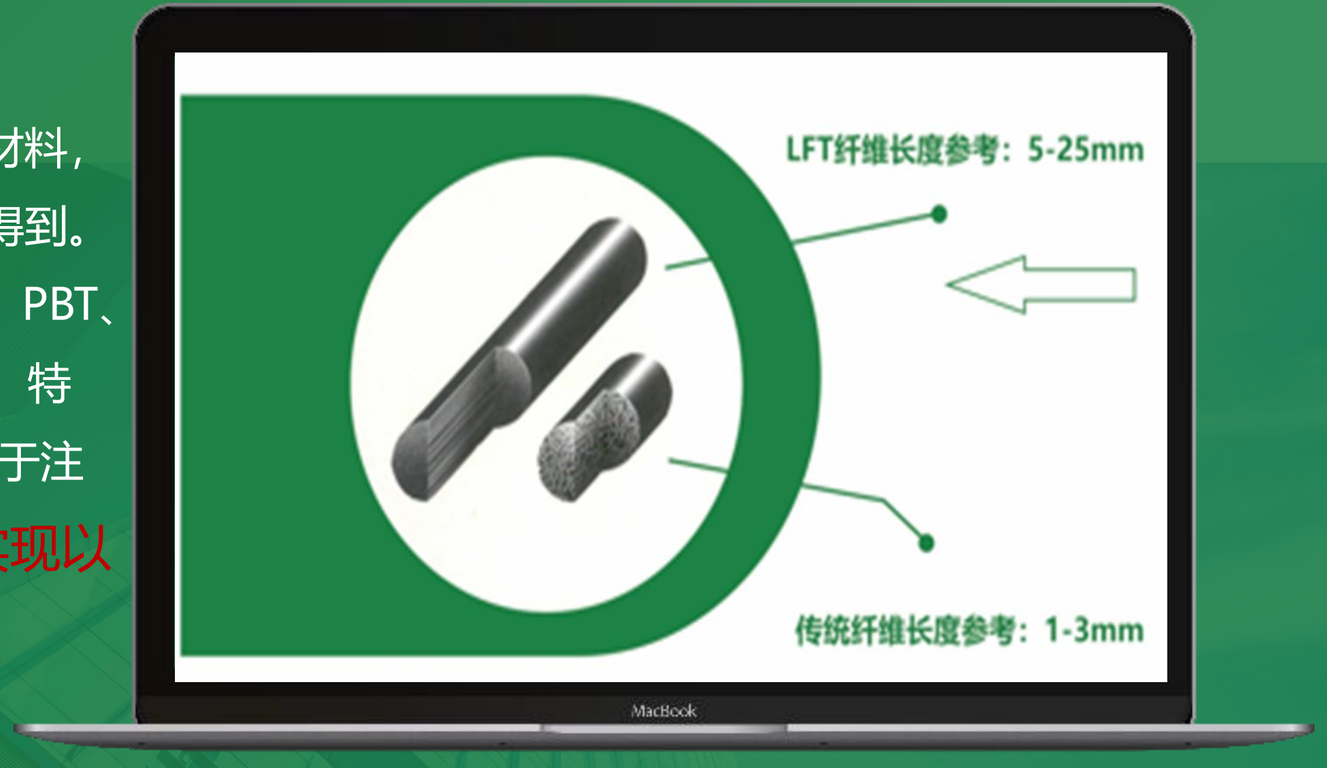
注塑碳纤维材料介绍

Introduction to Carbon Fiber Injection Molding Materials

Polygram

热塑性LFT长碳和短纤维增强改性材料区别：

短碳纤长度为1~2毫米，LFT工艺生产的热塑性复合材料，长度可达到在5~25毫米以上，可经过专用的模具浸渍工艺得到。采用最多的基体树脂是PA6、PA66、PPA、PA12、MXD6、PBT、PET、TPU、PPS、LCP、PEEK等。常规纤维有玻纤、碳纤，特殊纤维有玄武岩纤维与石英纤维等;根据不同用途，LFT可用于注塑成型、挤出、模压等，机械性能优异，在很多领域可实现以塑代钢或带代替热固性材料。



LFT long fiber reinforced thermoplastic engineering materials, comparedto ordinary short fiber reinforced thermoplastic materials (fiber length isless than 12 mm), the LFT process produces thermoplastic engineeringmaterial's fibers in lengths of 5-25 mm. The long fibers are impregnatedwith the resin through a special mold system to obtain long strips that are fully impregnated with the resin, and then cut to the length asrequired.The most used base resin is Pp, followed by PA6, PA66, PPAPA12,MXD6, PBT, PET, TPU, PPS, LCP PEEK. etc。Conventional fibersinclude glass fiber, carbon fiber, special fibers include basalt fiber andquartz fiber, etc. Depending on the end use, the finished products canbe used for injection molding, extrusion, molding, etc. or directly usedfor plastic instead of steel and thermoset products.

注塑碳纤维材料介绍

Introduction to Carbon Fiber Injection Molding Materials

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一张图告诉您什么是注塑碳纤维

One Image Explains What Carbon Fiber Injection Molding Is

长碳纤原丝

Long Carbon Fiber Precursor

LFT长纤维颗粒

LFT Long Fiber Pellets

短切碳纤维原丝

Chopped Carbon Fiber Precursor

SCF短碳纤维颗粒

SCF Short Carbon Fiber Pellets

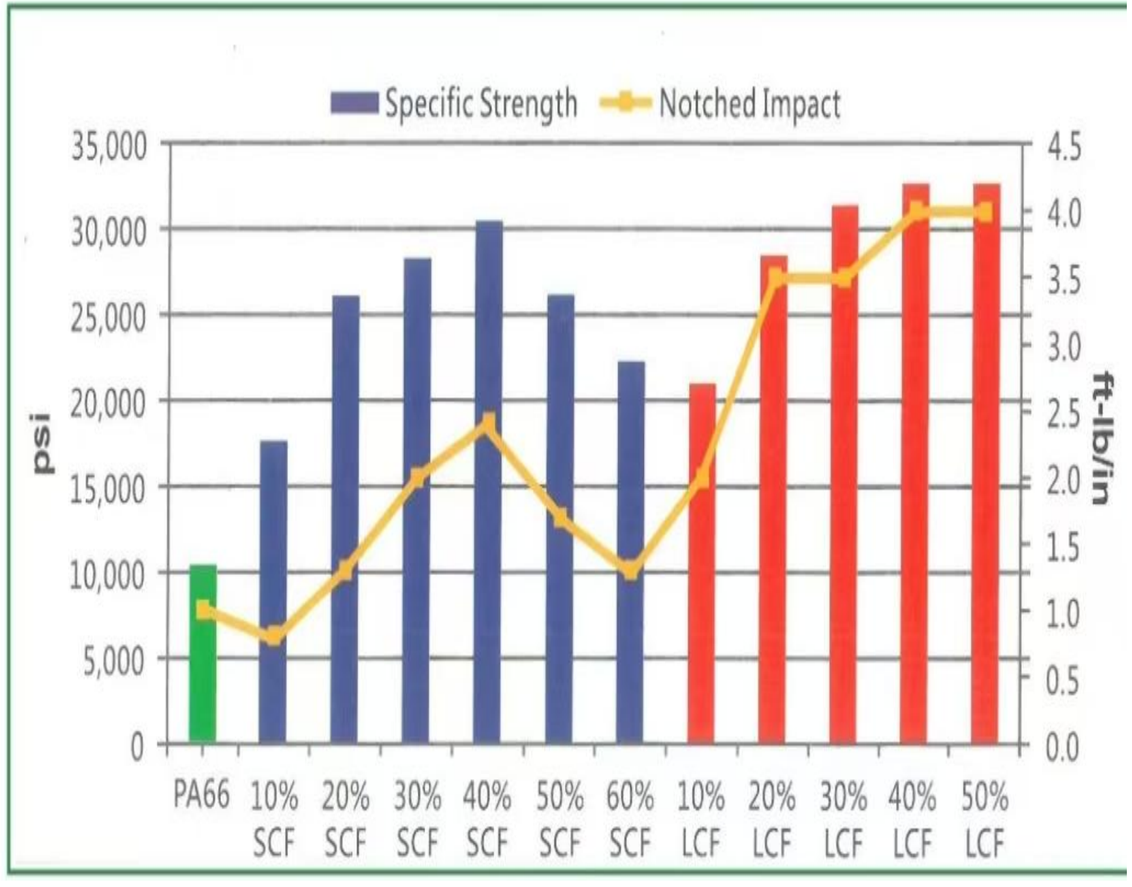
热塑性增强热塑性复合材料

材料经过复合后，长碳纤与短碳纤各具有不 同的性能和用途类别，是最具轻量化 的特种工程塑料，注塑出来的产品集高强度和高冲击于一体，刚柔并济+高效低成本，是替代金属和传统热固碳纤维制品的一种新工艺。

After compounding, the material exhibits distinct performance characteristics and application categories. As a high-performance engineering plastic with excellent lightweight properties, the products molded by injection boast a combination of high strength and high impact resistance, achieving a perfect balance between rigidity and toughness while ensuring high efficiency and low cost. It is a new technology that can replace metal components and traditional thermoset carbon fiber products.

典型测试数据：
Typical Test Data

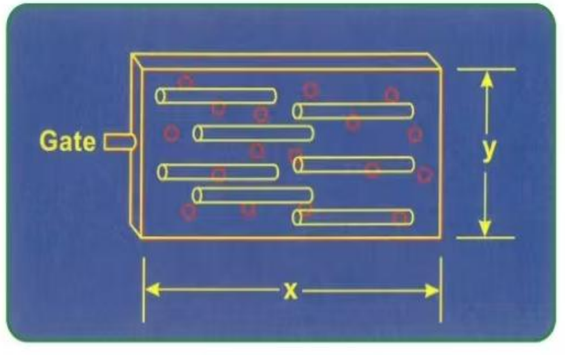
长碳纤与短碳纤增强尼龙的性能对比测试
Performance Comparison Test of Nylon Reinforced with Long and Short Carbon Fibers



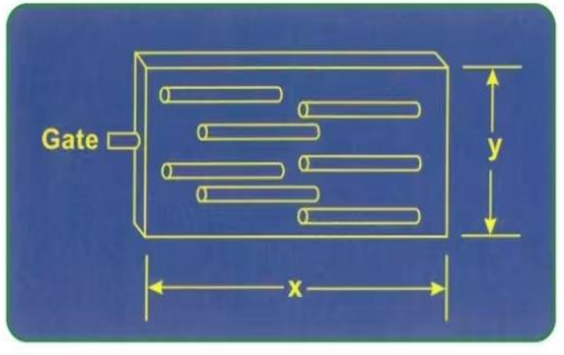
机械性能对此
Mechanical Properties Comparison

拉伸性能测试
Tensile performance test

弯曲性能测试
Bending performance test



强度及翘曲控制
Strength&Warp Control



翘曲控制
Warp Control

典型测试数据：
Typical Test Data

Polygram

材料对决：注塑碳纤维 vs 铝合金**核心物理性能对比**

Material Duel: Carbon Fiber (Injection Molding) vs. Aluminum Alloy – Key Physical Properties

性能指标 **Performance Parameters**	注塑碳纤维(30%碳纤增强 **Injection Molded CF (30% Carbon Fiber Reinforced**	铝合金 (6061) **Aluminum 6061**	核心优势 **Core Advantages**
密度 Material Density	.25-1.3g/cm^3	2.7g/cm^3	减重52%-54% Weight saved: 52%–54%
拉伸强度 Tensile Strength	120-140MPa	110-130MPa	强度持平，比强度超2倍 Equal strength, specific strength more than doubled.
弯曲模量 Flexural Modulus	6000-7000MPa	6800MPa	刚性接近，满足结构要求 Similar rigidity, meeting structural requirements.
工作温度 Operating Temperature	-40°C~130°C	-50°C~120°C	耐温性相当 Equivalent heat resistance

结论：注塑碳纤维在工艺效率、成本控制及NVH性能上具有显著优势，是未来轻量化的优选方案。

Conclusion: Injection-molded carbon fiber offers significant advantages in process efficiency, cost control and NVH performance, making it an optimal solution for future lightweighting.

轻量化革命：E-BIKE车架减重与安全的完美平衡

Lightweight Revolution: The Perfect Balance of Weight Reduction and Safety for E-BIKE Frames

名称Name：E-BIK自行车车架

产品材料Resin:LFT长碳纤注塑件

材料缩水率ShrinkRate:2/1000

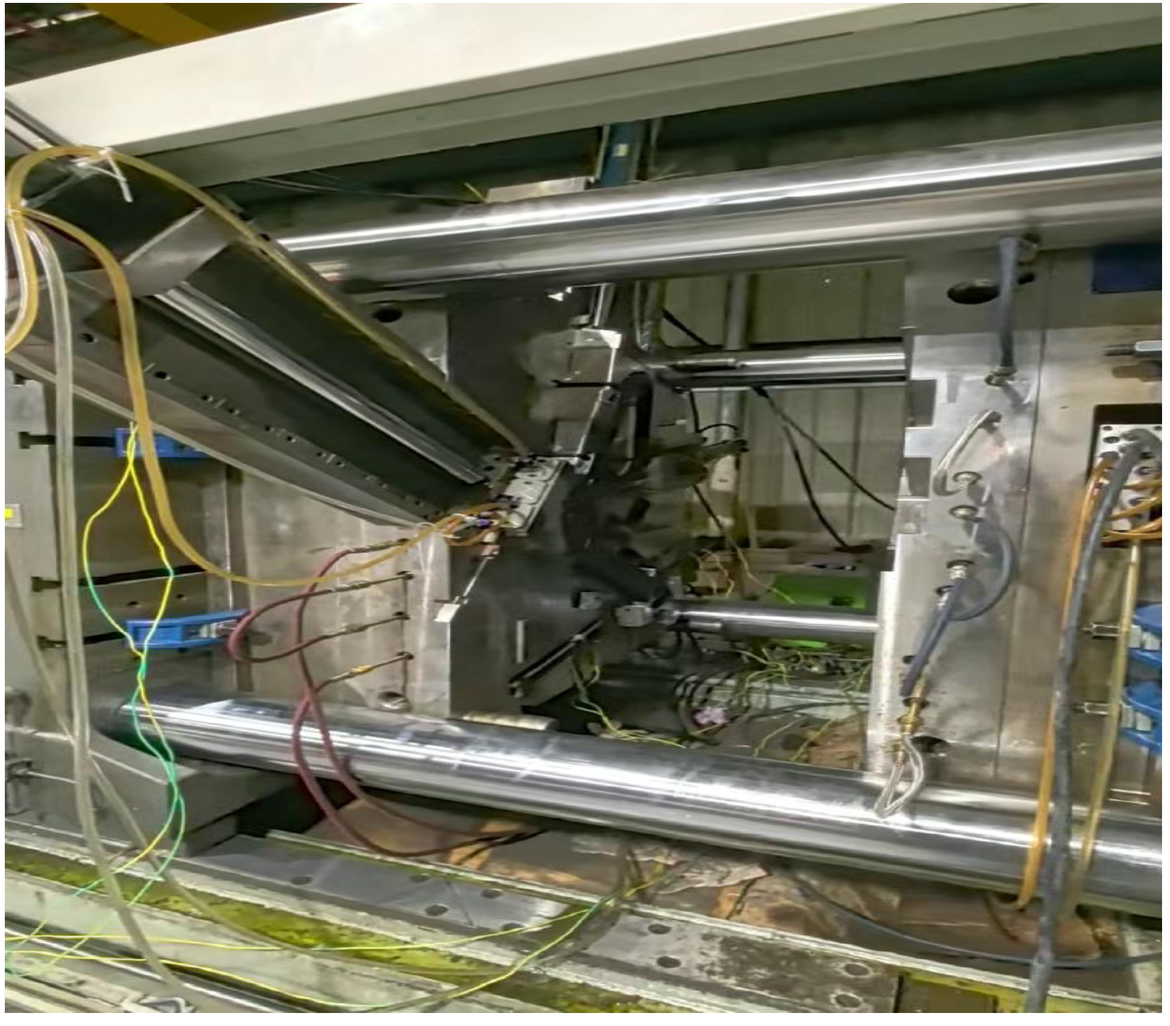
产品单重UnitWt:3700g

产品颜色Color:黑色 Black

注塑机台Tonnage:1300T

模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:429s



轻量化革命：助力自行车配件减重

Lightweight Revolution: Weight Reduction for E-Bike Components

名称 Name:自行车配件

产品材料 Resin:LFT-MXCF

材料缩水率 Shrink Rate:3/1000

产品颜色 Color: 黑色Yellow

注塑机台 Tonnage:350T

模具穴数 Mold Cavities:1*1

注塑周期 Injection Cycle:40s

样品零件检测报告

1）报告编号	2）收样时间	3）开始时间	4）完成时间	5）检测周期
LTTR202506060054	2025/6/6	2025/6/9	2025/6/9	2H

送检原因：☑ 新产品； 设计更改； 老供应商； 新供应商（上线）； 新供应商（导入中）； 其它；

零件名称 :8405左碳杆刹车杆	零件图号 :92.8405.003.000	A 千分尺（MICROMETER）	F 半径规（RADIUS GAGE）	L 盐雾试验箱（SALT SPRAY CHAMBER）
零件材料:PA6+50%GF	零件制造商 :思翔	B 游标卡尺（VERNIER CALIPERS）	G 螺纹规（THREADS GAGE）	M 百分表（DIAL INDICATOR）
零件总模数数:	送检阶段：☑ T0；☐ T1；☐ T2；☐其它；	C 显微镜（MICROSCOPE）	H 高度规（HEIGHT GAGE）	N 粗糙度仪（ROUGHNESS TESTER）
送样人:刘神浩	送样次数:钟诚	D 光学投影仪（OPTICAL PROJECTOR）	I 洛氏硬度计（ROCKWELL HARDNESS TESTER）	P 针规(Ping Gauge)
检测报告类型：☑ 首图检测； ☐ 供应商检测；		E 塞规（PLUG GAGE）	J 维氏硬度计（VICKERS HARDNESS TESTER）	3D 三次元（CMM）
报告编写人 :模示科	报告审核批准人:	2D 二次元（OMM）	K 布氏硬度计（BRINELL HARDNESS TESTER）	O 其它（OTHER）_____

首件样板的制造过程：1.毛坯（☐ 注塑 ☐ 冲压 ☐ 铸造 ☐ 粉末冶金 ☐ 机加 ☑ 其它。 ），2.表面处理（ ☐喷涂 ☐喷砂 ☐电镀 ☐抛 ☐印 ☐印 ☐金 ☐雕 ☐它。 ）

测量位置序	图区	是否关键尺寸	尺寸	上公差	下公差	量测工具	第一模腔 样板1	第一模腔 样板2	第一模腔 样板3	第二模腔 样板1	第二模腔 样板2	第二模腔 样板3	第三模腔 样板1	第三模腔 样板2	第三模腔 样板3	第四模腔 样板1	第四模腔 样板2	第四模腔 样板3	剖开检测	是否在规格公差内	更改建议 更改零件	更改图纸	备注
1	E1	是	18.5	0	-0.3	B	18.03	18.09	18.09											NG			
2	C2	是	13	0.2	-0.2	2D	13.01	12.99	13.05											OK			
3	B4	是	41.8	0.2	-0.2	2D	41.89	41.92	41.91											OK			
4	E4	是	M3-6H			G	OK	OK	OK											OK			
5	A4	是	4.1	0.05	-0.05	P	4.10	4.11	4.11											OK			
6	A5	是	8.1	0.05	-0.05	P	8.11	8.12	8.12											OK			
7	A5	是	0	0.08	0	3D	0.07	0.06	0.06											OK			
8	D5	是	7.3	0.05	-0.05	P	7.34	7.33	7.35											OK			
9	D6	是	0	0.08	0	3D	0.06	0.05	0.06											OK			
10	C4	是	5.8	0.05	-0.05	P	5.82	5.84	5.84											OK			

其他检测项目：
外观检测：表面无毛刺、披风现象，结果OK.
装配功能检测：
盐雾测试条件及结果：
硬度检测要求及结果：
其它项目要求及结果：强度测试合格，施加45KG力，重复测试10次，未出现断裂，百格测试合格

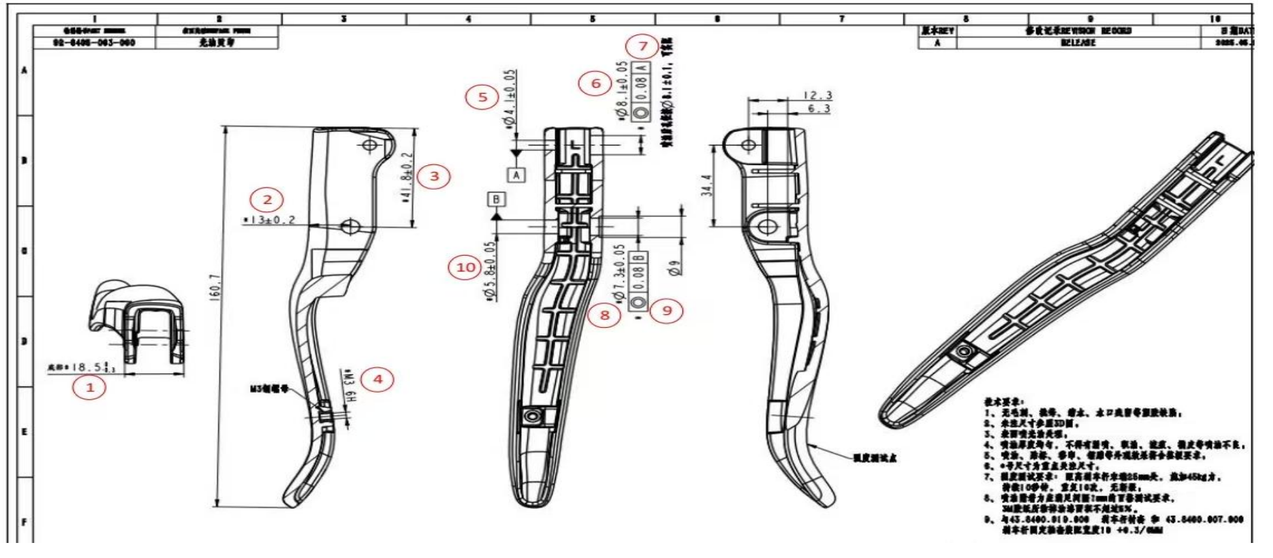
结论：
☐飞全接受，可用于试产。
☐ 完全接受，直接用于生产，不试产理由：
☐ 条件接受： 可用于生产，条件接受理由：
☐ 全接受： 试产后才可用于生产（附试产总结报告）
☐ 拒绝接受。

批准意见（供应商则由技术部门填写）

研发工程师： 日期：

研发负责人： 日期：

说明：
1.新零件的送样（包括研发新物料、设计变更物料、新引入供应商的送样、以及老零件因供应商尺寸、材料、工艺等任何变更而产生的新物料），供应商必须对样件进行全尺寸检查（把图纸上的关键尺寸在“是否关键尺寸”里标识为“是或者否”），并按本格式出具报告首件检测报告，并和其他性能的测试作为确认送样的附件，没有本检测报告，监图不接受该样件；
2.监图品质出具的首件检测报告经过研发审核后，作为研发对新物料工程确认的官方文件（监图首件检测报告和图纸、样品、供应商首样检测报告一起，一式三份，分别研发留底、采购转供应商、品质IQC来料检验使用），结论必须是完全接受接收时，采购方可通知供应商做大货；



轻量化革命：航空航天**应用领域**

Lig htweight Revolution: Aerospace Applications

名称 Name:流体炮弹壳

产品材料 Resin:LFT-MXCF

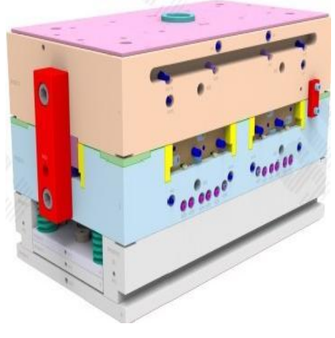
材料缩水率 Shrink Rate:3/1000

产品颜色 Color: 黑色Yellow

注塑机台 Tonnage:350T

模具穴数 Mold Cavities:1*1

注塑周期 Injection Cycle:40s



轻量化革命：低空经济**应用领域**

Lightweight Revolution: Applications in the Low-Altitude Economy Sector

名称 Name:无人机机架及桨叶

产品材料 Resin:LFT-PA66

材料缩水率 Shrink Rate:3/1000

产品颜色 Color: 黑色Yellow

注塑机台 Tonnage:250T

模具穴数 Mold Cavities:1*2

注塑周期 Injection Cycle:30s

轻量化革命：警用装笨应用领域

Lightweight Revolution: Applications in Police Equipment

名称Name:警用头盔/消防头盔

产品材料Resin:LFT长碳纤注塑件

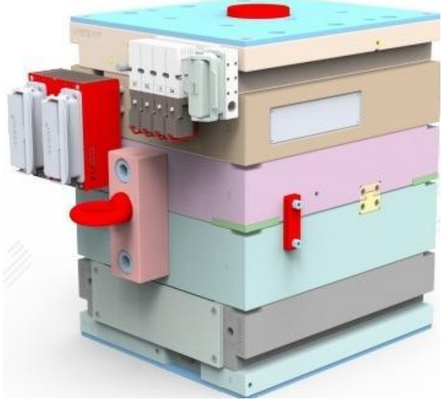
材料缩水率ShrinkRate:2.5/1000

注塑浇口InjectionGate: 扇形式进胶

注塑机台Tonnage:450T

模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:29s



轻量化革命：化工泵业**应用领域**

Lightweight Revolution: Applications in the Chemical Pump Industry

名称Name:磁力泵/隔离套

产品材料Resin:SCF短碳纤注塑件

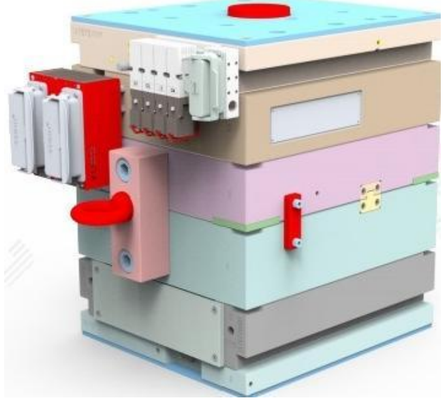
材料缩水率ShrinkRate:2.5/1000

注塑浇口InjectionGate: 扇形式进胶

注塑机台Tonnage:450T

模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:29s



轻量化革命：电力叶轮**应用领域**

Lightweight Revolution: Applications in Power Impeller Industry

名称Name:风叶转子

产品材料Resin:SCF短碳纤注塑件

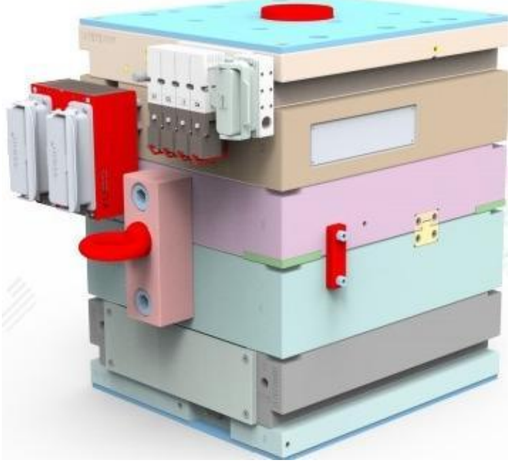
材料缩水率ShrinkRate:2.5/1000

注塑浇口InjectionGate: 扇形式进胶

注塑机台Tonnage:450T

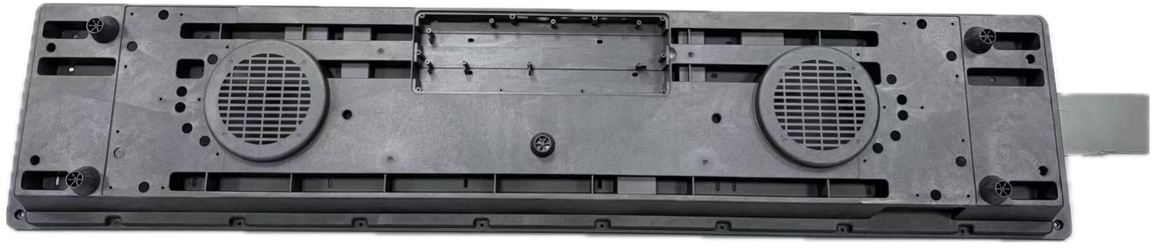
模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:29s



轻量化革命：音乐器材**应用领域**

Lightweight Revolution: Applications in Musical Instruments



名称Name:音乐器材

产品材料Resin:SCF短碳纤注塑件

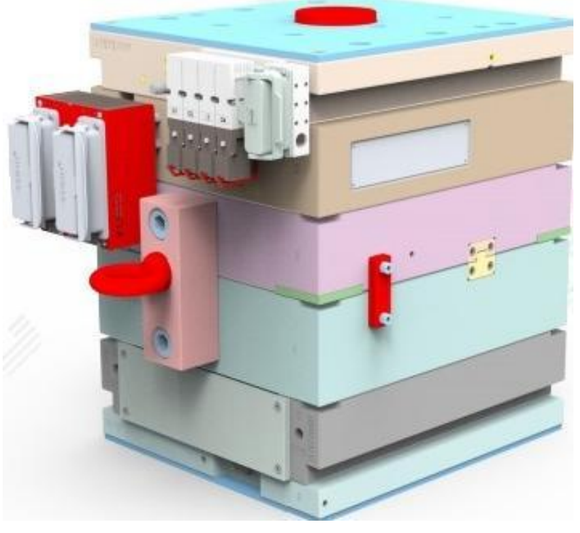
材料缩水率ShrinkRate:2.5/1000

注塑浇口InjectionGate: 扇形式进胶

注塑机台Tonnage:450T

模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:60s



轻量化革命：电子电器应用领域

Lightweight Revolution: Applications in Electronics & Electrical Appliances

名称Name:电子电器

产品材料Resin:SCF短碳纤注塑件

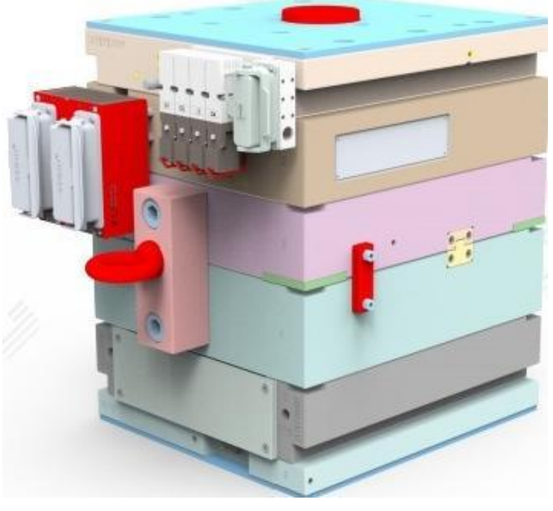
材料缩水率ShrinkRate:2.5/1000

注塑浇口InjectionGate: 扇形式进胶

注塑机台Tonnage:450T

模具穴数Mold Cavities:1*1

注塑周期InjectionCycle:29s



导电/防静电复合塑料介绍

Introduction to Conductive/Antistatic Composite Plastics

导电/防静电复合材料：

是一类通过特殊改性，使其具备导电、耗散静电或者屏蔽电磁干扰能力的工程塑料，它综合了塑料的轻质、易加工和金属的部分电学特性，产品系列有：ETFE、PVDF、PFA、FEP、PEI、PA12、PPA、PPS、PEEK这类材料按导电能力和主要功能，可分为抗静电塑料、静电耗散塑料、导电塑料和结构型导电塑料；主要应用领域：电子于半导体、电磁屏蔽、防爆与安全、其他工业领域。

Conductive/Antistatic Composites

This is a category of engineering plastics endowed with conductivity, electrostatic dissipation or electromagnetic interference (EMI) shielding capabilities through special modification. It integrates the lightweight and easy processability of plastics with partial electrical properties of metals. Classified by conductivity and primary functions, such materials fall into four types: antistatic plastics, electrostatic dissipative plastics, conductive plastics and structural conductive plastics. Their main application fields include electronics and semiconductors, electromagnetic shielding, explosion protection and safety, as

PEEK导电/防静电材料系列：

PEEK Conductive/Antistatic Material Series

等级	基础材料	表面电阻	特性	应用场景
静电消散型	PEEK碳纳米管防静电(CN5019)PEEK carbon nanouube anti stntc(CN5019)	10E6-10E9	特性:防静电，导电，导热，耐磨，耐高温，耐化学腐蚀，自润滑，阻燃，耐水解 Features: Antstatic, eleclricalconductivitythermal conductivity, wear resistance, high temperature resistance, chemical corrosion resistance,self-lubricating,flame retardant,hydrolysis resistance.	机械配件，医疗器械零部件，油筛，半导体制造设备，泵件。 mechanical parts/componentsmedicaldevice components/partsoilscreen/filter semiconductormanufacturing equipmentpump components/parts
	PEEK碳纤维防静电(CF5119)PEEK carbon ¡ber ant-statie 《 .你 5|1'%)			
导电型	PEEK碳纳米管导电(CN5419)PEEK carbon nanotube conductive (C N89)	10E3-10E5		
	PEEK碳纤维导电(CF5999)PEEK carbon Ãber conductive (C fs999)			

PBT导电/防静电材料系列：

PBT Conductive/Antistatic Material Series

等级	基础材料	表面电阻	特性	应用场景
静电消散型	PBT碳纳米管防静电(CN1913)PBT carbon nanotube anti-static (CN1913)	10E6-10E9	特性:防静电，导电，强度高，耐溶剂，耐水解 Features:Anti-static, conductive, high strength, solvent resistance, hydrolysis resistance	开关零件、家用电器、配件零件、小型电动罩,汽车点火线圈绞管和各种电器连接器等。 Switch parts, housthold appliances, accesonautomobilparts,smallcie ctrieCOVCrSabesand variougnicion coil rwiredcjeetrieal connectors, ct
	PBT碳纤维防静电(CF6543)PBT carbon fber anti-static(CF6543)			
导电型	PBT碳纳米管导电(CN4913)PBT carbon nanotube conductive (CN4913)	10E3-10E5		
	LCP碳纤维导电(CF7544)LCP carbon fber conductive (Cf7544)			

POM导电/防静电材料系列：

POM Conductive/Antistatic Material Series

等级	基础材料	表面电阻	特性	应用场景
静电消散型	POM碳纳米管防静电 (CN5411)POM carbon nanotubti-scatic (CN541 1)	10E6-10E9	特性:防静电，导电，超耐磨，机械性能优良，高刚性，耐有机溶剂性佳，自润滑 Features: Anti-static, conductive, high toughness, wear resistance, weather resistance, cold resistance, high temperature resistance,high bending modulus.	齿轮，轴承、仪表内件等。 Gears, bearings, instrument internal components, etc.
	POM碳纤维防静电(CF9764)POM carbon fber a1			
导电型	POM碳纳米管导电(CN8876) 导电型 POM carbon nano Conductive grade tubes are conductive (CN88760	10E3-10E5		
	POM碳纤维导电(CF9321) POM carbon fber is conductive (CF9321)			

石墨烯散热复合塑料介绍

Introduction to Graphene Thermal Dissipation Composite Plastics

石墨烯散热复合塑料：

是通过将高导热的石墨烯作为填充与塑料复合，从而创造出兼具优异散热性、轻质及可加工性的新材料，相比传统金属散热材料，它具有轻质、耐腐蚀、易加工成型、可设计性强等优点；我们攻克了石墨烯在塑料中分散不均和与基体界面结合弱的导致导热性能无法发挥的技术痛点；应用领域：电子散热、汽车轻量化、及航空领域。

Graphene Thermal Dissipative Composite Plastic

It is a new material with excellent thermal dissipation, light weight and processability, fabricated by compounding highly thermally conductive graphene as a filler with plastic. Compared with traditional metal heat dissipation materials, it boasts advantages such as light weight, corrosion resistance, easy processing and molding, and high design flexibility. We have addressed the technical pain points of uneven dispersion of graphene in plastic and weak interfacial bonding with the matrix, which previously hindered the exertion of thermal conductivity. Application Fields: Electronic heat dissipation, automotive lightweighting, and aerospace sectors.

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石墨烯散热复合塑料应用案例：

Application Cases of Graphene Thermal Dissipation Composite Plastics

充电宝散热器
Power Bank Heat Sink

汽车模组散热器
Automotive Module Heat Sink

摄影器材散热器
Photography Equipment Heat Sink

户外灯散热器
Outdoor Light Heat Sink

电池壳散热器
Battery Case Heat Sink

电子散热器
Electronic Heat Sink

展望未来

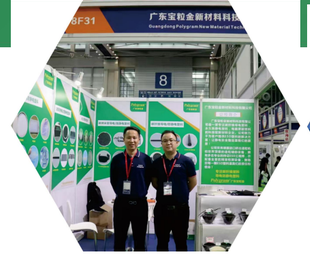
Looking forward to the future

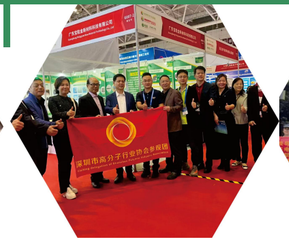
宝粒金将持续聚焦于热塑性碳纤增强复合材料的尖端技术，

我们不仅在材料性能上深化，还不断在应用场景上突破。

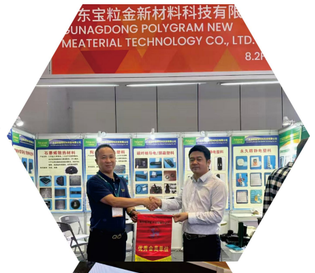
宝粒金致力于成为全球领先轻量化解决方案的合作伙伴，与客户携手突破材料极限，产品终端；共同塑造更轻、更强、更可持续的未来工业图景。

After compounding, the material exhibits distinct performance characteristics and application categories. As a high-performance engineering plastic with excellent lightweight properties, the products molded by injection boast a combination of high strength and high impact resistance, achieving a perfect balance between rigidity and toughness while ensuring high efficiency and low cost. It is a new technology that can replace metal components and traditional thermoset carbon fiber products.





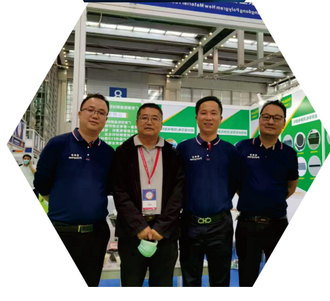













长纤维(LFT)注塑螺杆设计理念及优化方案

Long Fiber (LFT) Injection Screw Design Concept and Optimization Scheme

设计理念 Designconcept

① 核心目标 Core obiectives:

- 减少纤维在塑化过程中的剪切断裂,保持纤维长度(>5mm),确保最终制品力学性能(强度、韧性、抗疲劳性)。
- Reduce the shear fracture of the fiber during plasticization andmaintain the fiber length(>5mm)to ensure the mechanicalproperties of the final product(strength, toughness, fatigueresistance)。

② 关键挑战 Key challenges

- 传统螺杆的高剪切力会导致纤维断裂,需通过结构优化降低剪切速率,同时保证塑化均匀性。
- The high shear force of conventional screws can lead to fiberbreakage,and structuraloptimization is required to reduce the shearrate while ensuring plasticizing uniformity.

螺杆工艺参数 Screw process parameters

Polygram

材料选择与表面处理

Material selection and surface treatment

① 螺杆材质

双合金钢(如钨钴合金涂层),提高耐性,减少纤维磨损螺杆。

② 表面处理

氮化或镀铬处理,降低熔体黏附,减少纤维滞留

Screw materialDouble alloy steel (such astungstencobalt alloy coating),improve wearresistance,reduce fiber wear screw.

② Surface treatmentNitriding or chrome platingtreatment,reduce melt a

低剪切螺杆

ow shear screw

采用长径比(L/D)较小(如18:1~20:1)、螺槽较深的螺杆,降低剪切速率。避免使用高剪切混炼元件(如屏障型螺杆)

The screw with small lengthdiameter ratio (L/D) (such as 18:1~20:1) and deep screw groove is used to reduce theshear rate, Avoid highshear mixing components (such as barrier screws)

螺杆转速控制

Screw speed control

转速通常控制30~70 rpm,过高转速(>100rpm)会因剪切热和机械力导致纤维断裂

The speed is usually controlled at 30 to 70 rom, and too high a speed [>100 rom) will cause fiber breakage due toshearheatand mechanicalforces.

背压调节

Back pressure regulation

背压不宜过高(<5 Mpa),避免熔体在螺杆前端过度压缩和摩擦。

he back pressure should not be too high (<5 MPa is recommended) to avoid excessive compression and friction ofthe melt at the front end ofthe screw.

优化方向与验证方法 Optimization direction and verification method

优化方向 optimization direction

① 剪切速率模拟:
通过CFD(计算流体力学)软件模拟熔体流动,优化螺深度和螺纹角度。
Shear rate simulation:The melt flow is simulated by CFD(Computational Fluid dynamics) software to optimize the groove depth and thread Angle.

② 纤维长度检测:
使用显微镜或CT扫描检测制品中纤维长度分布,验证螺杆设计效果。
Fiber length detection:Use a microscope or CT scan to detect the fiber length distribution in the product to verify the design effect ofthe screw.

③ 耐磨性测试:
通过长时间连续生产,评估螺杆涂层的耐久性。
Wear resistance test:Evaluate the durability of screw coatings through continuous production over along period oftime.

实际案例对比 Comparisonofactualcases

指标	传统螺杆	优化后螺杆
纤维保留率 Fiber retention rate	50%-60%	80%-90%
制品拉伸强度 Tensile strength of product	120MPa	180MPa
螺杆使用寿命 Service life of screw	6-12个月	18-24个月

长纤维（LFT)注塑模具设计核心要点

Key points in the design of long fiber (LFT) injection molds

以下是一份关于碳纤维注塑模具设计与制造的完整方案,涵盖设计要点、材料选择、制造工艺及质量控制,适用于汽车、航空航天、消费电子等领域的高性能碳纤维增强塑料(CFRP)制品生产。

The following is a complete plan for the design andmanufacture of carbon fiber injection molds, coveringthe design points, material selection, manufacturingprocess and quality control for the production of highperformance carbon fiber reinforced plastic (CFRP)products in the automotive, aerospace, consumerelectronics and other fields.

模具材料 Mold material

基体材料 Base material

① 高硬度、高耐磨性:推荐预硬钢(如S136，S136H)。

High hardness, high wear resistance: recommendedpre-hard steel(such as S136H, H13, hardness HRC4550)
or carbide (tungsten steel)。

② 耐高温抗腐蚀（如：8407、8418、8503不粘钢料)或硬质合金(钨钢)

Corrosion resistance: If the resin contains glassfiber/carbon fiber additives, optional stainless steel (suchas 17-4PH)。

表面处理 Surface treatment

① 涂层技术:DLC(金刚石涂层)、CrN(氮化铬)或TiAIN(氮铝钛)涂层,降低摩擦系数，减少纤维损伤。

Coating technology: DLc(diamondlike coating),CrN(chromium nitride)or TiAlN (nitrogen aluminumtitanium) coating, reduce friction coefficient, reducefiber wear.

② 表面抛光:型腔表面需镜面抛光(Ra<0.1um)，减少流动阻力,避免纤维滞留。

Surface polishing: the surface of the cavity needsmirror polishing (Ra<0.lum) to reduce flow resistanceand avoid fiber retention.

模具结构设计 Mold structure design

01

浇注系统
Gating system

① 浇口类型:优先采用扇形浇口或直接浇口,避免针点浇口的高剪切(碳纤维易断裂)。

Gate type: Fan gate or direct gate is preferred t o avoidhigh shear of pin point gate (carbon fibe r is easy to break).

②流道设计:圆形或梯形截面流道，直径比普通模具大20%30%(如主流道直径>8mm)

Flow channel design: circular or trapezoidal flo wchannel, the diameter is 20%30% larger than the ordinarymold (such as the main channel dia meter >8mm)。

02

排气系统
Exhaust system

排气槽深度:0.020.03mm(防止溢料),位置设在熔体流动末端和镶件接缝处

真空辅助排气:对复杂件采用真空抽气,减少气泡和碳纤维分布不均

Exhaust tank depth :0.020.03mm(to prevent overflow),located at the melt flow end and insertjoi nt.Vacuum assisted exhaust: vacuum pumping is use dfor complex parts to reduce the uneven distributio n ofbubbles and carbon fibers.

03

冷却系统
Cooling system

① 随形水路:3D打印随形冷却水路(铜合金材质),确保均匀冷却,减少热应力变形。

With the shape of the water :3D printing with thesh ape of the cooling water (copper alloy material), toe nsure uniform cooling,reduce thermal stressdeform ation.

② 冷却液温度:模温控制在90-200度(视树脂类型而定,如PEEK需更高温度)。

Coolant temperature: mold temperature controlat 8 0120° c(depending on the type of resin, such asPEE K needs a higher temperature).

分型与顶出设计 Parting and ejection design

分型面 Parting surface

① 尽量减少分型面数量,避免飞边影响纤维取向。

Minimize the number of parting surfaces to avoid flash affecting fiber orientation

② 采用斜面或阶梯分型,降低开模阻力。

② Use inclined plane or step parting to reduce mold opening resistance.

顶出机构 Ejector mechanism

① 顶针材质:氮化钨钢,顶针直径加大(防止碳纤维磨损卡死)

Thimble material: tungsten nitride steel, thimblediameter increased(to prevent carbon fiber wearstuck)。

② 延迟顶出:保压结束后延迟25秒顶出,避免未固化件变形。

Use inclined plane or step parting to reduce mold opening resistance.Delay ejection:

温控设备建议

Temperature controlequip ment recommendations

使用高精度模温机(PID控制)或油电混合加热系统,确保温度稳定性。
配合热电偶或红外传感器实时监测模具表面温度，闭环反馈控制。

The use of high precision mold temperaturemachin e (PID control)or hybrid heating system to ensure temperature stability.Realtime monitoring o f mold surfacetemperature with thermocouple or in frared sensor,closed-loop feedback control.

特殊注意事项

Special note

碳纤维导热性:碳纤维的高导热性可能导致局部散热过快,需调整加热策略。
Carbon fiber thermal conductivity: The highthermal conductivity of carbon fibe r may lead to loca!heat dissipation too fast, and the heating strategyneeds to be adjusted.

脱模剂兼容性:高温下需选用耐高温脱模剂,避免残留或分解。
Release agent compatibility:At high temperatures, hightemperature releas e agentsshould be selected to avoid res idue or decomposition。

成本与性能优化方案 Cost and performance optimization

模具成本控制 Mold cost control

案例参考与数据对比Case reference and data comparison

项目 (Item)	传统模具方案 (Traditional mold scheme)	优化和模具方案 (Optimization and mold scheme)
模具寿命 (Die life)	20万模次 (200,000 modules)	50万模次 (500,000 modules)
制品表面粗糙度 (Product surface	Ra 0.8μm	Ra 0.1μm
纤维保留率 (Fiber retention rate)	70%	90%
单模成本 (Single mold cost)	¥30万 (¥300,000/road)	¥45万 (图层+随形水路) (¥450,000 (Layer + accompanying waterway))

其他辅助措施

Other auxiliary measures

① 纤维取向控制 ①Fiber orientation control

- **通过模流分析(如Moldflow)预测纤维分布,优化浇口位置和冷却系统,使纤维沿受力方向有序排列。**
- The fiber distribution is predicted by mode flow analysis (e.g., Moldflow), and the gate location andcooling system are optimized so that the fibers are orderly arranged al ongthe force direction.

② 后处理工艺 ②Post-treatmenttechnology

- **对制品进行退火处理(低于树脂熔点10~20°C),释放内应力,减少因残余应力导致的纤维-基体界面剥离。**
- The product is annealed (10~20'c lower than the resin melting) to release the internalstress and reducethe stripping of the fiber-matrixinterface caused by residual stress.

注塑工艺参数 Injection molding process parameters

Polygram

熔体温度

适当提高熔体温度(比普通注塑高10~20°C),降低树脂黏度,减少纤维与熔体间的剪切摩擦。但需避免温度过高导致树脂降解。

**Melt temperature **Appropriately increase the melt temperature(10~20c higher than ordinary injection molding).
reduce the viscosity of the resin, and reduce the shear friction
between the fiber and the melt. However, it is necessary to avoid
resin degradation due to excessive temperature.

注射速度

采用中低速注射(填充时间延长10%~20%),高速注射会因高剪切导致纤维断裂。可通过多段注射控制:初始，低速(避免喷射),中段 提速,末端降速

|niection speed
Medium and low speed iniection is used (the filling time is extended by 10% to 20%), and highpeed iniection will cause fibebreakage due to high shear.It can be controlled by multi-stage
injection: initial low speed (to avoid injection), increased speed in
the middle,and reduced speed at the end.

保压压力与时间

降低保压压力(为常规材料的60%~80%)并缩短保压时间,减少熔体在高压下的二次剪切。

** Holding pressure and time **
Reduce the holding pressure (60% to 80% of the conventional
material) and shorten the holding time, reduce the secondary shear
ofthemeltunderhigh pressure.

长纤维（LFT)注塑加工过程注意事项

Precautions for long fiber (LFT) injection molding

在碳纤维长纤维增强热塑性复合材料（LFT）的注塑加工过程中，为确保操作安全和产品质量，需特别注意以下事项：

In order to ensure operational safety and product quality during the injection molding of carbon fiber long fiber reinforced thermoplastic composites (LFTs), special attention should be paid to the following:

个人防护

注塑压力需高于普通塑料（因熔体粘度高），需要穿戴防护面罩、护目镜、安全鞋;防止因注塑过程中积聚防止因注塑过程中由于材料长时间在炮筒停留碳化导致注塑机压力过大而产生喷射的状况发生。

The injection pressure should be higher than that of ordinary plastics (due to the high viscosity of the melt), and protective masks, goggles, and safety shoes need to be worn; Prevent accumulation during the injection molding process and prevent injection due to excessive pressure on the injection molding machine due to the carbonization of the material staying in the barrel for a long time during the injection molding process.

注塑设备安全

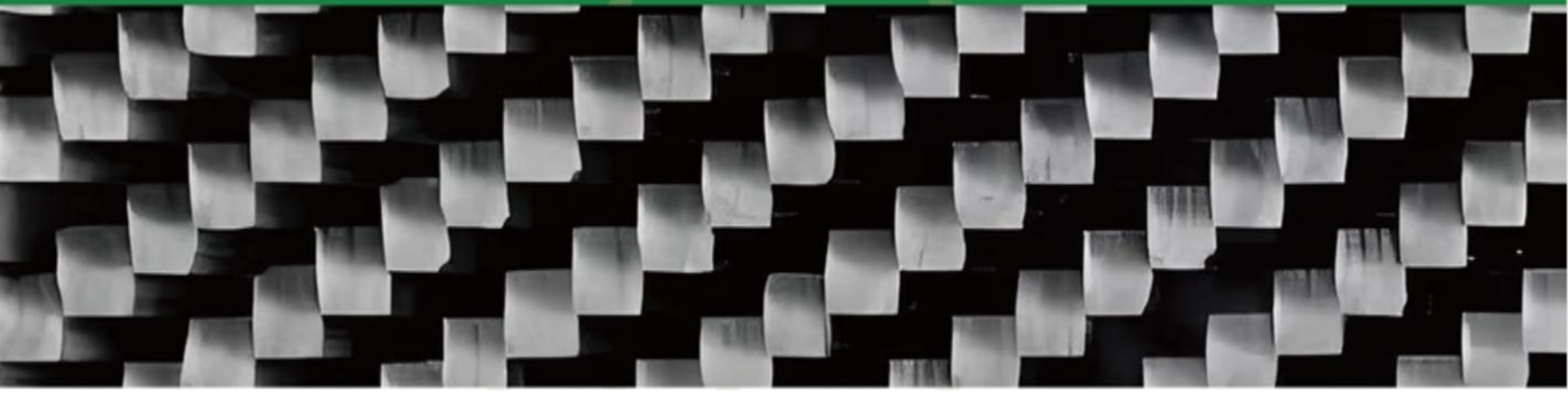
螺杆和模具耐磨：碳纤维对金属磨损性强，定期检查螺杆、料筒和模具的磨损情况，避免设备损坏导致泄漏或故障。

Screw and mold wear resistance: carbon fiber is highly abrasive to metal, regularly check the wear of screw, barrel and mold to avoid leakage or failure caused by equipment damage.

后处理注意事项

注塑成型工艺完成后应立即清理炮筒螺杆中的材料残留，防止因纤维停留造成炮筒碳化堵塞

After the completion of the injection molding process, the material residue in the barrel screw should be cleaned immediately to prevent the carbonization and blockage of the barrel caused by fiber retention



谢谢您的观赏

Thank you for your time