INTAMSYS
infinite possibilities

FREE WHITEPAPER ON PEEK 3D PRINTING

PEEK 3D PRINTING

“PEEK 3D Printing shall transform various industries from medical to automotive and open up a whole new world of opportunities.”

PEEK is considered king of polymers for its excellent mechanical, chemical and thermal properties. But so far it has been very difficult to 3D Print this material due to various reasons. Read this whitepaper to learn more about PEEK material and how 3D Printing PEEK can bring in whole new world of opportunities.

INTRODUCTION TO PEEK

PEEK belongs to a family of semi-crystalline thermoplastics called Polyaryletherketone. PAEK (Polyaryletherketone) is considered the king of polymers for its excellent thermal, chemical and mechanical properties. PAEK has high temperature stability and high mechanical strength.

PAEK has a continuous operating temperature of 250 °C (482 °F) and under short-term loads can function up to 350 °C (662 °F). When burned it has the least toxic and corrosive fumes. It also has a low heat output when burned, so it qualifies for use in interior aviation applications. It also has good overall chemical resistance.

It has a tensile strength of 85 MPa (12,300 psi) and a Young's modulus of 4,100 MPa (590,000 psi). Its yield strength is 104 MPa (15,100 psi) at 23 °C (73 °F) and 37 MPa (5,400 psi) at 160 °C (320 °F). It does not break in an un-notched Izod impact test.

Plastics that fall into PAEK family include:

- PEK
- **PEEK**
- PEKK
- PEEKK
- PEKEKK

PEEK (Polyether ether ketone) is a colorless organic thermoplastic polymer in PAEK family used for engineering applications. PEEK is a semi crystalline thermoplastic with excellent mechanical and chemical resistance properties that are retained at high temperatures. The processing conditions used to mold PEEK can influence the crystallinity and hence the mechanical properties.

PROPERTIES OF PEEK

The Young's modulus for PEEK is 3.6 GPa and its tensile strength 90 to 100 MPa. PEEK has a glass transition temperature of around 143 °C (289 °F) and melts around 343 °C (662 °F). Some grades have a useful operating temperature of up to 250 °C (482 °F). The thermal conductivity increases nearly linearly with temperature between room temperature and solidus temperature. It is highly resistant to thermal degradation, as well as to attack by both organic and aqueous environments. It is attacked by halogens and strong Bronsted and Lewis acids, as well as some halogenated compounds and aliphatic hydrocarbons at high temperatures. It is soluble in

concentrated sulfuric acid at room temperature, although dissolution can take a very long time unless the polymer is in a form with a high surface-area-to-volume ratio, such as a fine powder or thin film. It has high resistance to biodegradation.

	PEEK	LCP Polyster	Nylon
Density g/cc	1.30 – 1.32	1.35 – 1.40	1.13 – 1.15
Tensile Strength	10,000 – 15,000	16,000 – 27,000	14,000
Tensile Modulus	500K	1400K – 2800K	230K – 550K
Tensile Elongation	30% - 150%	1.3% - 4.5%	15% - 80%
Impact Strength	0.6 – 2.2	2.4 – 10	0.55 – 1.0
Hardness	R120	R124	R120
CLTE	40 – 47	25 – 30	80
HDT	320F	356F – 671F	180F

APPLICATIONS OF PEEK

Because of its robustness and excellent properties, PEEK is used to fabricate items used in demanding applications like aerospace components, bearings, piston parts, pumps, HPLC columns, compressor plate valves and cable insulation. It is one of the few plastics compatible with ultra-high vacuum applications. PEEK is considered an advanced biomaterial used in medical implants, e.g. use with high-resolution magnetic resonance imaging (MRI) for creating a partial replacement skull in neurosurgical applications. It is finding increased use in spinal fusion devices and reinforcing rods.

PROCESSING PEEK

PEEK melts at very high temperature when compared to various other thermoplastics. So, the most common method to process PEEK is injection moulding. Machining is also done on PEEK material except that PEEK is very expensive material and machining leads to lot of wastage. Only recently have companies explored the possibility of 3D Printing PEEK. INTAMSYS has one such machine FUNMAT HT, that can 3D Print PEEK.

3D PRINTING PEEK

Till recent past, PEEK material has been available in powder form alongside sheets and rods. So, SLS (Selective Laser Sintering) was being used to 3D Print PEEK. But the SLS process is very expensive. Only recently did companies start making PEEK material in filament form. APIUM is one such company that manufactures PEEK filament.

APIUM has graduated from PEEK filament manufacturer to become the first company to release commercial FFF 3D Printer capable of printing PEEK material. Other than APIUM, only handful companies in world have machines capable of 3D Printing PEEK. INTAMSYS FUNMAT HT is one such 3D Printer in the market.

There were multiple difficulties in the path to 3D Print PEEK. According to Charles Han, CEO of INTAMSYS, “PEEK melts at a very high temperature of 350 – 400 degrees centigrade. Though we do have the all metal hot-ends that can go upto such high temperatures, maintaining the heat within the object during the printing process for effective bonding of the layer is the biggest challenge to overcome. That is why it is very difficult to print objects with high build volume and with high resolution. This problem can be partly overcome by heating the chamber and maintaining the chamber temperature. But it is very difficult to maintain uniform temperature across the entire build volume and also at this temperature the mechanical properties of the motors used for axis movement alter and also undergo thermal expansion. We have come up with very innovative design to overcome this issue. So, our machine is capable of 3D Printing PEEK without any undesired results.”

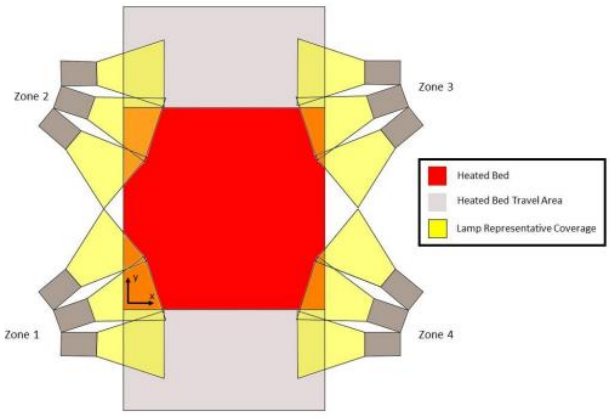
NASA has done a similar research on PEI 3D Printing (a material very similar to PEEK in its properties) and detailed their work on their

website. They took an off the shelf desktop 3D printer and made changes to print PEI material.

Below are the various changes they have made to a low end 3D Printer to print PEI material. The same modifications do apply for PEEK 3D Printing as well

- Electronics & Machine Enclosure
- All-Metal Hot End
- IR Heating Lamps
- Stepper Motor Coolers
- Firmware
- Electronics

Two major important aspects to look into here are Stepper Motor Coolers & IR Heating Lamps. Rest other modifications are already implemented in various desktop 3D Printers. A detailed explanation of the process is documented and listed in NASA website. (link)



WHY 3D PRINT PEEK

PEEK is the most coveted polymer for various applications. Its properties are similar to various metals and thus can be used to replace metals thereby bringing down the product weight and thus increasing the fuel efficiency. But since the material is very expensive, many are restricting to the not-so-optimal alternatives for their products.

Machining PEEK leads to lot of wastage and thus is economically unviable and so is the creation of mold for injection molding PEEK, esp. when the quantity required is less. 3D Printing fills this gap very well. We can lower down the cost of PEEK processing (and thereby final PEEK components) by 3D Printing PEEK and this opens up whole lot of opportunities. As PEEK is chemically inert, there are lots of applications in medical field where custom implants are required.

3D PRINTING PEEK IN MEDICAL

Medical grade PEEK has been used for creation of medical implants. OsteoFab material developed by Oxford Performance Materials has been FDA approved to create patient-specific cranial devices, facial devices and spinal implants. So far, SLS 3D

Printing has been used to sinter the powder and create the medical implants.

SLS 3D Printing is however very expensive. Therefore PEEK in filament form is potentially attractive for the creation of custom implants at a price that is much less expensive than the laser sintered variety.

Currently there are FFF machines that can 3D Print medical grade PEEK filament. INTAMSYS is working towards developing one such machine for medical grade PEEK filament (as of 01st May 2017).

FUTURE OF PEEK

With more and more companies entering PEEK 3D Printing space, many more suppliers of PEEK material shall emerge thus leading to a major drop in PEEK prices. This encourages many more people to explore PEEK material and we believe cycle continues till PEEK becomes the preferred polymer for various applications.

According to experts, users may use PEEK to replace CNC Machining and metal parts. Because of its unique thermal and chemical properties, PEEK can be used for end parts in place of metal alloys.

ABOUT INTAMSYS

INTAMSYS is an industrial 3D Printer manufacturer from Shanghai, China renowned for PEEK capable 3D Printer, FUNMAT HT. The company has a portfolio of 4 machines to suit the varied needs of industrial customers. The company is headquartered in Shanghai, China and has manufacturing facilities in Nanjing and Dongguan. Please visit www.intamsys.com to know more.

REACH OUT TO US

Website	www.intamsys.com
E-mail	info@intamsys.com
Phone	+86-21-5846 5932
Facebook	fb.com/intamsys
Twitter	@intamsys_3d

INTAMSYS

SHANGHAI INTAMSYS TECHNOLOGY CO. LTD.

3rd Floor, Building C9, No. 3188 Xiupu Road,

Pudong New District, Shanghai, PRC – 201315

www.intamsys.com | info@intamsys.com | 021-5846 5932