



# Expanding Applications and Opportunities with PolyJet™ Rapid Prototyping Technology

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## ABSTRACT

PolyJet™ 3-dimensional rapid prototyping technology, first introduced to the market in 2000, has been proved to address the needs of a wide range of industries and applications.

With installations at leading manufacturers around the world, Objet has accumulated a great deal of experience in applying PolyJet technology in a wide range of industries, including footwear, toys, automotives, consumer goods, industrial manufacturing, and many more. Hundreds of companies, amongst them many of the world's largest in their fields, are using PolyJet -based RP systems in their design and manufacturing processes. By handling all RP in-house they can ensure confidentiality throughout the design process, reduce the risk and cost of error, promote team creativity and reduce time to market.

Through hands-on customer experience, Objet found that new applications for rapid prototyping could be realized by enabling accurate models that closely resemble the end product "look and feel" as well as its functionality.

By combining proven technology with a wide range of materials, it is possible to bring the advantages of rapid prototyping to a broader range of industries and also vastly expand the applications within those industries. This is particularly true for the manufacturing of plastic goods. For example, in shoe manufacturing, the ability to genuinely feel the flexibility of the end product by bending the model of the sole would enable design adjustments early in the design cycle, avoiding time-consuming changes later in the process.

PolyJet technology jets ultra-thin 16-micron layers of Objet's FullCure® photopolymer materials, delivering exceptional accuracy and allowing any geometry, including thin walls, overhangs and even moveable parts. Currently, Objet is investing significant resources in developing new materials and extending the applicability of PolyJet technology.

**Key words:** Rapid Prototyping, Photopolymer, Jetting, Inkjet, Resins

## INTRODUCTION

The manufacturing world is increasingly turning to 3D printing in an effort to meet the requirements for rapid time to market in today's competitive market place. By solving engineering problems as early as possible in the development process companies can save costs and progress more swiftly from concept to finished product.

Objet's advanced PolyJet™ technology, featuring ultra-thin build layers and the Objet family of FullCure® materials, enables more industries to embrace the technology and expand applications within each industry.



## POLYJET TECHNOLOGY

PolyJet 3-dimensional rapid prototyping technology, first introduced to the market in 2000, has been proved to address the needs of a wide range of industries and applications.

With installations at leading manufacturers around the world, Objet has accumulated a great deal of experience in applying PolyJet technology in a wide range of industries, including footwear, toys, automotives, consumer goods, industrial manufacturing, and many more. Hundreds of companies, amongst them many of the world's largest in their fields, are using PolyJet -based RP systems in their design and manufacturing processes. By handling all RP in-house they can ensure confidentiality throughout the design process, reduce the risk and cost of error, promote team creativity and reduce time to market.

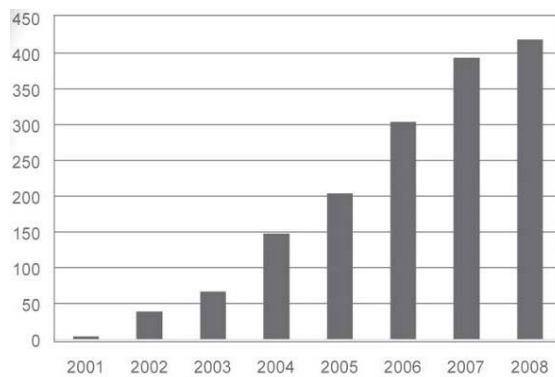


Fig. 1. Users WW adopt Objet's PolyJet™ Technology

PolyJet technology jets ultra-thin 16-micron layers of Objet's FullCure photopolymer materials, delivering exceptional accuracy and reproducing any geometry, including thin walls, overhangs and even moveable parts. Each layer includes both model and support materials. The support material is necessary to enable jetting of overhangs, cavities, holes, etc. The jetting head slides back and forth along the X axis depositing a single super thin layer of photopolymer onto the build tray. Immediately after building each layer, UV bulbs alongside the jetting bridge emit UV light and cure each layer. The internal tray moves downwards with extreme precision and the jet heads continue building until

the model is complete. The finished model is fully cured and does not require any post curing. Once the support is removed, the model can immediately be used.

Today, Objet is investing significant resources in developing new materials and extending the applicability of PolyJet technology.

## FullCure Material Family

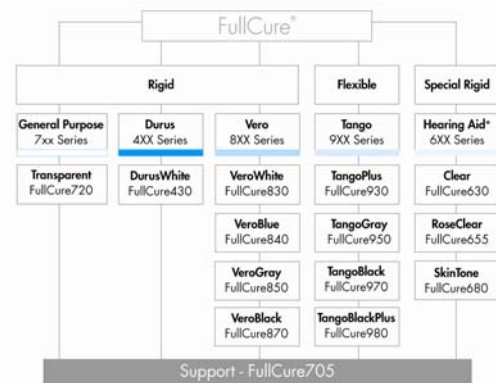


Fig. 2. Objet's FullCure Family of Materials

FullCure is Objet's family of proprietary resins, including acrylic-based photopolymer materials. Based on Objet's PolyJet technology, the materials produce fully cured models. The materials are delivered in fully sealed 2kg, 3.6kg and 1.44kg in 3.6kg casing.

A single Support material is used with all model materials.

The FullCure family benefits are:

### Productivity

- Instant curing ready to use models
- No lengthy post process required.

### Flexibility

- Choice of materials enables a wide variety of applications
- Transparent, colored, opaque, flexible and rigid materials
- Specialized materials for Hearing Aids



**Ease of Use**

- Same support material for all materials
- Easily removable gel-like Support - no hard grid edges
- Easy loading and unloading of cartridges
- Easy switching between materials

**Environmental Safety**

- Delivered in fully sealed cartridges
- No skin or eye contact

**Diversified Finishing**

- Model surfaces readily absorb paint
- Models can be machined, drilled, chrome-plated, glued or used as a mold



Fig 3. 3.6kg cartridge

**The FullCure720**, a transparent rigid material, is suitable for a broad range of rigid models, particularly where visibility of liquid flow or internal details is needed. The material is also biocompatible and suitable for various medical applications.

Its main characteristics are: Tensile Strength: 60.3 MPa, Elongation at break: 15–25%, Modulus of Elasticity: 2,870 MPa, Flexural Strength – 75.8 MPa.



Fig. 4. FullCure720 Transparent Model

**The Vero™ series** of materials makes it possible to produce opaque models that closely resemble the “look” of their target products. The opaque surface enhances visualization of details and edges.

Enhanced properties such as Thermal Resistance of 43-49 °C, toughness of 25J/m and Flexural strength of 75-85MPa, allow Vero family to be used intensively when functional testing of engineering parts is required in prototyping, pre-production, production verification, form/fit/function testing, RTV molding patterns and more.

Available as VeroWhite™, VeroBlue™, VeroGray™ and VeroBlack™, the range of colours enables numerous applications in different industries. For example, VeroBlack enables consumer electronics or automotive manufacturers to simulate the look of black end-products without painting.

VeroGray specifically features an excellent detail visualization and dimensional stability. These characteristics make this modeling material the best choice for models in transit



Fig. 5. The Vero Series

**The FullCure430 DurusWhite™**, Polypropylene-like material addresses a broad range of applications requiring polypropylene-like appearance, flexibility, strength and toughness such as reusable containers of various types, laboratory equipment, loudspeakers, automotive components and more. Properties include Izod Notched Impact of 44 J/m, Elongation at break of 44% and Flexural Modulus of 1026 MPa and enable simulation of polypropylene resistance to fatigue and snap-fit functionality over time.



Fig.6.FullCure430 DurusWhite Model

**Rigid Materials summary**

The table below demonstrates the best usage of FullCure rigid materials

Usage	FullCure 720	Vero White	Vero Blue	Vero Gray	Vero Black	Durus White
Smooth Surface	+++	+++	+++	+++	+++	+++
Engineering Simulation	+	+	+++	+++	+	+
Models in Transit	+	+	++	+++	+	+
Medical App.	+++	+				
Detail Visualization		+	+++	+++	++	+
Snap Fit App.	+	+				+++
Semi – Transparent App.	+++					

+ Good    ++ Very Good    +++ Excellent

Fig 7. Rigid Materials summary.

The **Tango™** series of model materials embraces new applications by providing different levels of elasticity, hardness and tear resistance.

The table below summarized the wide range of properties obtained by the Tango family

	TangoBlack	TangoGray	TangoPlus	TangoBlackPlus
Appearance	Black	Gray	Semi translucent	Black
Shore (Scale A)	61	75	27	27
Elongation at Break (%)	47	47	218	218
Tensile Strength (MPa)	2	4.36	1.45	1.45

Fig 8. Tango materials summary

The Tango parts enable the creation of models that closely resemble the “feel” of their target products, such as shoes (particularly athletic footwear), toys, and consumer electronics applications. Tango materials are also ideal for general industrial applications and rapid tooling. They are available in opaque (TangoBlack™, TangoGray™ and TangoBlackPlus™\*) and in translucent colors (TangoPlus™)

\*Subject to final testing results



Fig. 9. The Tango Series

The **FullCure® 6XX** materials are designed especially for the unique requirements of Hearing Aids (ear molds): Clear - FullCure630; RoseClear - FullCure655; SkinTone - FullCure680. With this group of materials, Objet is taking a great step forward towards rapid manufacturing.



Fig.10 . The FullCure 6XXX series

Some of Objet’s FullCure materials have medical approvals which indicate successful results for the following tests:

- Cytotoxicity
- Sensitization
- Irritation
- USP – Class VI – Plastic materials

All tests involve printed parts



The approvals are subject to post processing of parts as described in Objet's regulatory documents

FullCure family of materials is also used in specific concentrations and structures to generate composite Digital Materials™ based on PolyJet Matrix™ technology that is utilized on Connex family multi-material 3D printers.

Material	Medical Approvals
FullCure720	Cytotoxicity
	Irritation
	Sensitization
	USP Class VI
FullCure705	Genotoxicity, Ames test
	Irritation
	Sensitization
VeroWhite	Genotoxicity, Ames test
Hearing Aid Materials	Cytotoxicity
	Irritation
	Sensitization
	USP Class VI

## CONCLUSION

PolyJet technology has the capacity to grow with the rapidly changing requirements of the Rapid Prototyping market in the areas of material properties, resolution, speed, build size and other special feature requirements.

With the FullCure® family of materials being the perfect complement to PolyJet™ technology, more applications and solutions may be realized and shared with customers, to meet any rapid prototyping/manufacturing requirement they may have.

Fig 12. FullCure Family, Medical Approvals.

The FullCure family medical approvals suit a broad range of medical activities:

Example include:

- Surgery simulation
  - Reduction of surgical risks
  - Reduction of time and hospital costs
- Communication to patient
- Planning without necessity for patient presence
- And more

## REFERENCES

Wholers Report 2009, Rapid Prototyping and Manufacturing, Annual Worldwide Progress Terry Wholers, Wohlers Associates Inc

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