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Plastics In 3D Printing Markets: A Ten-Year Opportunity Forecast

A MARKET FORECAST AND TECHNOLOGY ASSESSMENT

PUBLISHED 2013

Chapter 1: Introduction

1.1 Background to this Report

The impetus behind this report's publication was SmarTech's belief that there was a need in the industry for an in-depth study of the evolving demand for polymers in the 3D printing/additive manufacturing industry. In an attempt to fill this perceived gap we have set out to apply our database of insider information and forecasting model to this important market.

SmarTech views plastics as an area of great opportunity for material companies over the next ten years. Supported by a proliferating user base of 3D printing machines and a growing reception in the engineering communities, plastics materials we believe that plastics will be a source of excellent revenue opportunities for materials firms, equipment firms and the retail/wholesale sector over the next decade. Conversely, the quantity and quality of plastic materials available for 3D printing systems are key determining factors in the number of 3D printers. Currently the plastic materials used in 3D printing include a lot of ABS and PLA, but also acrylate resins, epoxy acrylate resins, and nylon powder materials.

Meanwhile, many 3D printer firms are racing to fill out their plastic material portfolios. At the same time, major materials companies are also starting to see 3D printing as a profitable niche market worth jumping into now, with the promise of large opportunities to come. This has also led to 3D printing firms acquiring materials development companies and OEMs becoming major gatekeepers in the 3D-printed plastics supply chain. Today OEMs leverage their control over equipment design and distribution channels to secure material sales for their machines.

1.1.1 Nylon: Novel Materials and New Suppliers

Although the most visible parts of the 3D-printing materials market are the ABS and PLA sectors, it is actually the nylon sector that is the largest and this material will account for 30 percent of this market in 2019.

Nylon materials are being developed for functional prototyping and end-use manufacturing applications. Nylon can be used in high-temperature extrusion processes, but also has the melt characteristics to be used in laser sintering processes. Globally, Nylon 6 is the most commonly used nylon material for conventional manufacturing processes, including investment molding. Nylon 12, however, is the most commonly used nylon material for laser sintering AM processes.

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Nylon continues to make advances. One of the key trends is a growing ability to better control the internal structures of 3D printed nylon parts to encourage variations in fiber alignment thorough the part. This can improve the isotropic properties of the part and could even be used to program deformations into objects under stress.

This and other new developments in the nylon space are likely to turn 3D-printed nylon into a substantial business by the end of the decade. Nonetheless, the nylon powder supply chain for AM is best characterized as narrow. There are only a handful of manufacturers producing nylon powders for the 3DP industry. The major suppliers are: Evonik, Arkema, Arzuano, ExcelTec, and Rhodia. There are also some Chinese companies that manufacture suitable nylon powders for laser sintering processes.

1.1.2 Photocurable Resins: Up from Prototyping

For 30 years, resins have been selectively cured to form objects one layer at a time. In the thirty years since this technology debuted, 3D–printing resins have built a small but lucrative user base among prototyping engineers. **SmarTech** believes that the next ten years holds big opportunities in resins, driven by a large installation base of SL equipment, more functional resin materials, and end-use applications in the dental industry.

By the end of the decade, we expect the market for resins to be almost as big as the market for 3D-printed nylons. Nonetheless, resins largest applications will continue to be primarily in prototyping. SL equipment can produce highly accurate dimensional prototypes that can perform form-fit tests. These prototypes have had important impact on the automotive, medical, heavy machinery, and aerospace industries over the last two decades for parts ranging from gaskets to gears to hinges. SL equipment pushes into price tiers, SL are starting to have a greater impact in architectural, electronics, and other design oriented industries.

Nonetheless, we expect changes and improvements. Increasingly over the next 5-7 years, advances in resin will allow engineers to produce more robust parts for functional prototypes. These functional prototyping parts will find most immediate use in the performance automotive industry, automotive, and aerospace industries, for parts such as ducting, electrical housings, boxes, rings, etc. Photocurable resins have also found niche applications in the dental industry.

Supply chains for photo-initiated resins for the 3D printing industry are already quite well established. Due to the long history of these resins, there are a large number of chemical suppliers with both resin expertise and production capabilities more than willing to serve 3D resin material manufacturers. Nonetheless, we anticipate changes. **SmarTech** believes we will continue to see resin manufacturing operations move towards larger batch production as the market for

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professional stereolithography machines grows by over 20% annually over the next five years. We also see plenty of opportunity to develop more resistant SL resins over the next ten years. Resins whose properties open up new applications are perhaps the largest opportunity on the horizon.

DSM Somos, Sartomer (a division of Arkema), Allied Photopolymers, 3D Systems, Stratasys, EnvisionTec, Materialise, Solid Concepts, Sierra Resins, Rahn Group, Esschem, CMET, and Huntsman Advanced Materials are all major players in the professional photocuring resin market. Of these, DSM Somos is perhaps the largest.

1.1.3 ABS and PLA: Most Visible 3DP Materials

ABS has secured itself as the first medium for 3DP for the masses. It has benefited from nearly 30 years of companies working with it in prototyping applications. Traditionally, the lack of standardized filaments has historically fragmented the ABS filament market and prevented materials suppliers from pursuing larger production capacities. In the last few years, however, the industry has begun to rally around 1.75 filament diameter as a standard processing diameter.

We note here that equipment manufacturers have tried to use proprietary filaments to control the supply of materials, although this method is quickly out of vogue. Not only can diameter size of filament be quickly imitated by 3rd party material suppliers (providing no real long term barrier), it also create a lot of ill will from their consumer base because its so conspicuous.

The number of different ABS materials available for 3DP processes are unparalleled among other plastic materials. There are a number of high quality ABS products available in a bunch of different flavors. Different colors, transparencies, fire and chemical resistant properties, and even material that mimic other conventionally processed materials.

For all its beneficial properties, however, there are a number of challenges or limitations around ABS. The physical limitations of ABS material have defined many of the main challenges for personal 3D printing over the last ten years. Moving forward. Also, although ABS is the most visible 3D printing material in the marketplace, it will never generate the revenues of nylon or resins.

Meanwhile, PLA is being advanced for 3DP applications as a green alternative ABS. These actions mirror green initiatives in plastics for traditional casting processes that have made PLA second most plentiful plastic (in terms of weight) used in manufacturing applications. PLA is derived, in part, from renewable lactose that can be extracted from such sources as cornstarch, soybeans, tapioca roots, sugarcane, potatoes, wheat, and many other plants. Certain blends of PLA such as PLA 4043D have been engineered to be even more environmentally friendly. Already, many major material suppliers for 3DP offer PLA filaments, some even exclusively.

SmarTech sees 3D printing as one of the most promising areas of growth for PLA use over the next ten years. Some major manufacturers of PLA for conventional manufacturing applications are Nature Works, Toray Plastics, PURAC Biomaterials, Sulzer, Hitachi, and Thyssen Krupp, among many others.

In personal 3D printing, **SmarTech** sees the biggest opportunities in developing more robust ABS and PLA print materials to serve the serious hobbyist and off-time engineer class. More durable polymers like TPU, polycarbonate, and nylon are also intriguing and should win market share over the next ten years. New resin development will focus around more durable prototyping resins that can emulate manufacturing plastics for functional prototypes. Meanwhile, polymer powders for laser sintering may represent the largest opportunity in plastic materials.

Still, there are large gaps in performance and price for available plastics that will find large markets in different prototyping and end use applications. As eluded to earlier in the executive summary, 3D printing material demand is unlikely to increase in the magnitudes needed to drive real economies of scale through larger batch sizes. This means that cost efficiencies will likely be only incremental.

1.2 Goals and Scope of this Report

The objective of this report is to analyze all the key opportunities in the market for plastic materials used in 3D printing and how they are likely to change in the future. **SmarTech** sees the need for candid market assessment to help materials companies know where to get in and where the pitfalls lie. By helping to illuminate the business opportunities in 3D printing plastics, **SmarTech** also believes that we will be able to help dissolve information barriers and encourage investment in developing new 3D printing polymers.

In this report, we strove to provide comprehensive coverage of all the major polymer categories for the 3D printing industry over the next ten years, including those that don't exist yet (don't worry: they soon will). We provide forecasts for the total material demand by MT and market (millions $) for ABS, PLA, photosensitive resins, PC, PS, PP, TPU, Nylon 12, Nylon 11, Nylon 6, Bio-Degradable Plastic, High-Grade Thermoplastic powders (PEEK, PEK, PEKK), and Mid-Grade Thermoplastic Powders.

We also provide forecasts the total material demand by metric ton (MT) and market (millions $) for personal, professional, and production 3D printing materials.

1.3 Methodology of this Report

Most of the research for this report was conducted through first person interviews with experts in the plastics and 3D printing industry. Information collected through these interviews was cross-referenced within our 3D printing network and extensive database on the 3D printing industry to ensure accuracy. These interviews, along with our already robust dataset and industry expertise informed the critical assessment of shifting dynamics in the 3D printing industry.

The forecasts begun with our forecasts from our two reports: “3D Printing 2014: A Survey of SmarTech’s Annual Market Findings” published in May 2014 and “Markets for 3D Printing Materials: 2013-to-2022” published in October 2013. In this previous report, we made a detailed study of the equipment sales and installation base by every 3D printing company. In this report, we broke current installed equipment into personal, professional, and production 3D printers to capture the different usage patterns of these equipment classes.

We then made assumptions about the annual material used per printer per equipment category based on experts experience in both materials sales and 3D printing service bureaus to find the total amount of materials used per year. By looking at the individual applications of each printer category and customer segments, we were able to break down the demand for each polymer by equipment category. We then summed the demand for each polymer across equipment category and used an average price for each polymer material to find the total market for polymers in 3D printing over the next ten years.

As with all our forecasts, we have cross-referenced our numbers with professionals throughout the industry to ensure absolute accuracy. We also lay out our forecasts to allow our customers to understand exactly how we came to the numbers that we did. We have found that this provides our customers with the confidence to share these forecasts and use them to model potential business expansions.

1.4 A Note on Terminology

In this report, abbreviations are used for major plastic groups. Acronyms are announced at their first mention in the report. Additionally, a list of acronyms can be found at the end of this report.

There has been a lot of confusion in the 3D printing/additive manufacturing (AM) industry on the correct terminology for the industry: 3D printing or AM. The different names appeal to different customer segments. The masses consumers, hobbyists, and professional designers are content with 3D printing, as it captures the “coolness” of the process and the unlimited potential of this technology; on the other hand, engineers and manufacturers prefer AM because it can be taken more seriously as a real manufacturing process. Both terms essentially refer to the same collection of processes that add materials layer by layer to build an object from a digital file.

SmarTech has been disinclined to endorse one name over the other. We have found that choosing one specific name immediately alienates an entire portion of our customer base. In this report, **SmarTech** uses both terms to refer to essentially the same process. Whether we refer to 3D printing or AM is dependent on the context and what we believe is most relevant for our customers.

1.5 Plan of this Report

This report is intended to address the major opportunities in polymer materials within the 3D printing industry. Important polymers are broken down into chapters. In each chapter, **SmarTech** provides critical insight into the biggest opportunities and challenges for each polymer class. Among other topics, we address material production issues, raw materials, major manufacturers, industry capacity, distribution channels, target customer segments, environmental considerations, and shifting consumer preferences.

Chapter two and three explore the market for ABS and PLA polymers primarily for personal 3D printing. Chapter four addresses photocurable resins for sterolithography (SL) processes for consumer and professional applications. Chapter five explores professional and production opportunities for Nylon 6, 11, and 12 materials in depth.

Chapter six looks at more specialty materials that will find niche applications in different industries over the next ten years, such as the aerospace, automotive, and medical industries. This includes extensive assessment opportunities in high-grade thermopolymers in the PEAK family of polymers (i.e. PEEK, PEK, PEKK). Chapter six also addresses polycarbonate, polystyrene, HIPS, polypropylene, alternative biodegradable materials, and TPU. In addition, **SmarTech** addresses polymers that exhibit unique properties. This includes flexible and transparent polymer materials where **SmarTech** sees a large demand accruing over the next ten years.

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