developing a case for

ADDITIVE MANUFACTURING WITH CHEMCUBED

Chem^3's purpose is to create custom engineered emulsions for Additive Manufacturing, also known as 3-D Printing. It has become increasingly clear that materials designed for specific applications will be necessary as AM is adopted for more and more applications. These custom designed materials will not replace the general materials that printer manufacturers are supplying, but will allow the printers themselves become more versatile to applications where the general materials are not suitable. For instance, an application that would require the material to have specific thermal, mechanical or electrical properties, a custom material is needed. That is where Chem^3 has the solution.

Why Additive Manufacturing?

Basically the answer is simplicity and cost. With current software, it is easy to convert CAD designs to 3-D objects. Subtractive Manufacturing relies upon the removal of material to create something.
Subtractive Manufacturing requires machining, fixtures and tooling to make a new product lines. This could be cost prohibitive if you did not need a large production run. But with AM, you can make a single item of a specific design for modeling or short production runs without the fixtures and tooling and the waste that is typical subtractive manufacturing. This allows for a shorter product development timeframe as well as a lower cost per unit for short runs.

There are multiple printer technologies available for AM and each has pros and cons. First, the correct printer technology needs to be identified for the application. AM printers all build the object by creating layers of material. They differ by how the layers are constructed and by the varying materials used in the printer. Here is a brief list of popular types of 3-D printing:

- Stereolithography (SLA)
- Fused Deposition Modeling (FDM)
- Selective Laser Sintering (SLS)
- Photopolymer using piezo jet head
- Syringe Extrusion
- Selective Laser Melting (SLM)
- Electron Beam Melting (EBM)
- Laminated Object Manufacturing (LOM)

For building a metal object, SLS would usually be utilized. Developments are copious in this area to improve the process and metals as to combat the loss of mechanical strength when voids occur. One of the most popular and cost effective options of plastics printing is FDM. These printers usually have an extruded line of material (often PLA or ABS) on a roll. The roll is then fed into the printer and melted at the nozzle and cools as it's layered. The smaller the nozzle size, the higher the resolution, but also the slower the building process. Also, if the material does not have the correct melting and cooling characteristics, the object could have voids, lack of structural integrity, or loss of resolution. Using an inkjet head with a photopolymer has better resolution and ability to have a stronger build. Developments of a wider range of new materials are possible, since the photopolymers are cured and chemically bonded as they are building the object.

Advancements in materials in conjunction with strategic printer enhancements are needed for new applications in Additive Manufacturing. As companies evaluate how AM printing can best be adopted for their applications, many are finding it difficult to incorporate the technologies even though they see the potential. The purpose of Chem^3 is to use the

existing technology and develop new materials for these specialized applications.

Chem³ Technology

Chem³'s technology is centered on the use of polymer and polymer composite emulsions of rheology suitable for jetting by means of common, commercial piezo-effect inkjet "additive process" 3-D printing equipment. The new materials that are being researched and developed have specific physical, electrical and chemical characteristics needed for both jettability and final application specifications. As mentioned previously, developments of a wider range of new materials are possible using the piezo head, since the photopolymers are cured and chemically bonded as they are building the object. Adding Nano composite materials to our expertise in polymer science, Chem³ has the ability to make new application specific materials. Chem³ is able help a company match the printer to a custom emulsion suitable for individual applications.

There are presently no comparable products or services.

Example of servicing markets:

- 3-D additive mechanical and electrical parts specifically for energy efficiency in aircraft
- 3-D additive materials for optical devices
- 3-D additive dental appliances
- 3-D additive multi-layered small-scale circuit boards

Currently in development at Chem³:

- Stand alone materials for flexible printing electronics
- Printable protective coatings
- Optical materials
- Conductive materials
- Dielectric materials
- Hard Acrylic materials
- Biosensor materials

Dr. Daniel Slep serves as the Chief Technology Officer for Chemcubed. Dan's background includes positions that had him leading manufacturing, research and product development. In these positions, Dan has worked with many companies from start-ups to fortune 500 companies. Dan currently has an appointment as an Adjunct Professor in the Department of Materials Sciences & Engineering at the State University of New York. Dan is also currently serving on the External Advisory Board for Chemical Engineering at Stony Brook University, and also lectures about topics such as Additive Manufacturing, Polymer Engineering, and Nanotechnology. Dan's education includes a Bachelor's degree in Physics as well as a Master's degree and Ph.D. in Material Sciences. During his more than two decades in the printing Industry, Dan has published industry related articles, scientific papers and is inventor on multiple patents. To contact Dr. Slep, please email dslep@chemcubed.com or call 631.848.2950.