Selecting Digital Deposition Methods to Meet 2D and 3D Application Requirements

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Abstract

The paper outlines methods for effectively selecting digital deposition technologies for 2D printing and 3D deposition when there are dozens of technologies from which to choose. We present a matrix of parameters for comparing and evaluating the cost-effectiveness, performance capabilities and characteristics of currently available digital print and deposition technologies against the performance requirements of applications. The paper specifically cites 2D and 3D applications including folding carton production and plastic parts manufacturing requirements. The matrix structure provides researchers and technology developers with a flexible tool for fine-tuning the print and deposition technology selection process. This paper also examines how developers can use the matrix for integrating digital deposition technology into complex manufacturing assembly processes. Due to the space limitations that this publication affords, we provide the matrix in outline form with a few examples. Our research group has compiled a comprehensive matrix.

The digitally controlled deposition methods covered in this presentation include: the various forms of inkjet, inkjet-like methods, Inkjet Liquid Binding Powder (IJLBP), syringe deposit / Robo-casting (RC), aerosol deposit, pump dispensing, Electron Beam Freeform Fabrication (EB3F), Shape Deposition Manufacturing (SDM), and Fused Deposition Modeling (FDM)/Fused Filament Fabrication (FFF). We have focused for this presentation on methods where a digitally controlled process deposits material on a substrate or a particulate build material. In this report we do not cover spread-coating methods using radiation curing, such as laser electro-photography, stereo-lithography (SLA), selective laser sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), and Solid Ground Curing (SGC). Nor do we cover laminating build methods, such as Laminated Object Manufacturing (LOM). Our group covers these other technologies in an upcoming report. The matrix structures of all these reports will facilitate comparison of print, deposition and build methods against application requirements.

We focus on the characteristics of the deposition methods that address application requirements. These encompass both the way the deposition method performs and what it can deposit. Performance factors include the rate at which it can deposit amounts of specific materials, the accuracy and consistency of deposition placement, deposition resolution, the pH and deposit material device tolerances, material viscosity ranges necessary for deposition, system temperature controls and tolerances, operating, deposition material velocity, grey-scale capabilities, and device performance life. Users would also need capital and operation costs in selecting deposition systems. Operating costs will, however, vary greatly depending upon particular use. We therefore have not included operating costs in the current presentation matrix. Deposited material characteristics include viscosity, surface tension, and method to dry, solidify, polymerize, cure or fix. Performance requirements for deposited films and builds include abrasion and chemical resistance, tensile strength, and market acceptance of output appearance.

The report considers requirements for the following 2D applications:

- *Marking and coding*
- *Graphics printing*
- *Textiles*
- *Label printing*
- *Packaging*
- *Ceramics*
- *Glass*
- *Printed circuits*
- *Adhesives*
- *Masking for etching resist*

It also considers requirement for the following 3D applications:

- *Prototype models*
- *Casting models*
- *Architectural models*
- *Dental models*
- *Jewelry lost wax models*
- *Metal and polymeric parts replacements*
- *Photovoltaic deposition, masking, building*
- *Electronics connectors*
- *Buildings*

The requirements for these various applications can differ significantly. Deposition methods may be suited to meet the requirements of some applications while not being able to satisfy the requirements of others. Deposited material performance proves essential for meeting application requirements. The matrix structure helps to identify the digitally controlled deposition methods that satisfy the requirements of listed applications.