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Selective Inhibition Sintering: Advancements & Systematic Research approaches for the process development

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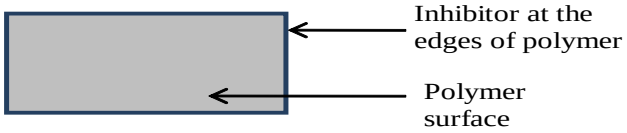
Abstract
SIS system is a new emerging Rapid Prototyping (RP) technique. Commercial rapid prototyping process like STL and electron beam melting produces the parts by infusion of laser energy. But in SIS process, parts are built by fusion of polymer powder particles in the part's body and preventing joining powder particles at the part boundary. Fundamental of SIS processes were investigated by several researchers. The polymer based SIS process has numerous advantages over the existing RP techniques. This paper discusses the major factor encounter in the development of polymer based SIS process, material selection, optimization of various input parameters, software and hardware design and development, fanatical path generation, application of response surface methodology which has led to optimum performance, factors affecting surface quality, strength of part and dimensional accuracy.

Keywords: Rapid prototyping, NC path generation, selective inhibition sintering, powder metallurgy and material selection etc.

INTRODUCTION

Since 1970 several rapid prototyping techniques were developed, some of which are commercialized and have directly being used in medical application, manufacturing industries and even in art. SLA (Sterolithography), SLS (Selective Laser Sintering), FDM (Fused Deposition Modeling) and LOM (Laminated Object Manufacturing) are the best known commercial RP system. In recent times, research on powder based Additive Manufacturing (AM). New approaches SIS have been developed to produce parts of high quality with polymers, ceramics and metals. SIS is a new emerging AM technique in which parts are built by joining polymer powder particles through sintering in the part's body and by sintering inhibition at selected powder areas at the part boundary. Sintering inhibition at the part boundary is performed by means of wetting the selected powder. In SIS process, indigenously available sintering inhibitors like potassium iodide, salt and other high temperature materials are spread on the first layer based upon the NC tool path generation from a CAD data. The inhibitors are sprayed on the periphery or outer edge of the component under consideration.



Each layer will be sintered (applying temperature below melting point uniformly) and subsequently cooled for some time. Then, another layer of polymer will be adding and inhibitor will take place. Continuous heating and cooling process occurs and the process continues until the computer sends the NC code generated for the specific CAD part to the nozzle system to manufacture the part. Each RP system has its own way of material processing technique; they use different polymer material to develop physical parts, because each polymer materials possess different properties. Process development of each RP system revealed a set of factors essential to develop functional system. A set of interdisciplinary approaches are required to develop each RP system because of the interplay between activities and simultaneous study. Therefore several series of trials were studies and conducted simultaneously.

A laboratory level machine was build to do initial research studies (figure 1). The machine includes the following parts.

1. **Source tank** unit is required to store fine powder of thermoplastic materials.
2. **Builder tank** unit is required, on which building of model takes place by receiving the powder from source tank.
3. **Collector tank unit:** the doctor blade pushes the excess powder to the collector tank from the build tank.
4. **Layer thickness adjuster / Z movement unit:** By providing appropriate values in layers and thickness the stepper motor moves the powder present in the source tank. At the same time the build tank will moves downwards to build the powder. The amount lowering movement sets the layer thickness in the final part.
5. **Inhibitor dispenser system and carrier unit / X-Y movement unit:** Dispenser carrier unit will moves X-Y direction at a time to create the required profile at Interpolation speed. The barrel and the hosepipe are connected to the control unit, which sprays liquid for inhibition on the plastic powder.
6. **Dispenser control panel:** It controls the amount of liquid used for inhibiting at the required pressure. By using pressure setter and pressure adjuster knobs, adjust the required air pressure to get a well defined profile in build tank at standard speed.
7. **Material spreader / doctor blade and carrier:** This will spreads the powder uniformly from source tank and excess powder will moves to collector tank. This will work with function of pneumatic system. When the X-carrier unit reaches the source tank after