

Statement of objectives

“An experiment is a question that science poses to Nature and a measurement is the recording of Nature’s answer” – Max Plank

From a very young age, I was fascinated with science and with its many innovations and technologies. It sparked an interest that prompted me to take a Bachelor’s degree in Mechanical engineering, which I believed was where new innovations, research and ideas emerged. As I have entered into engineering, the manufacturing domain attracted me a lot. The main reason is production of physical products, its testing, behavior, etc. and the domain never stopped me from learning. I had done a mini project titled **“Design and fabrication of plate jig”**. The aim of this project work was to design the plate jig for roof truss application and fabricate it with ease for unskilled labors as well as mass production. During the entirety of the course, the main project curriculum was designed in such way that it was required to work in teams. I was confused with the many domains and I wanted to do something different from traditional way. By that time the term “CFD” (Computational Fluid dynamics) started to show up in the design industries. We approached a guide who has received her Masters of Technology in CFD, from IIT Madras and was working in ANSYS corporation. She agreed to guide us. The next three months everyday early mornings were occupied with CFD and its uses in aerospace and automotive. The FEM/FEA models, boundary conditions, modeling and analysis of small components enabled me to understand about materials and its behavior with many external factors. The idea even driven us to do a project under the title of **“Single Row of holes of Turbine Blade Film Cooling Effectiveness using Computational Fluid Dynamics (CFD)”**. The aim of this project work was to study about the various viscous models of fluids. The turbulence flow of fluids in turbine blade has hot and cold medium. To avoid erosion of turbine blade due to hot fluid medium, the cooled air is passed through the holes and improved the cooling effectiveness of turbine blade and avoided the blade from erosion. The results were validated with experimental results. I was also fortunate to attend many seminars, workshops and lectures that fueled the embers for further study and explorations.

After completion of my Bachelor’s degree successfully (in first class with distinction), I got two job opportunities. Being the first graduate and came from very rural background in southern part of India, the friends and relatives urged me to take a design engineer job. But I wanted to explore more about what I learnt in last 4 years, By God’s grace, I became one among the top 10 candidates for Master’s degree Entrance examination conducted by Anna University,

one of the notable and old universities of India. I chose PSG college of Technology, Coimbatore because it is one among top 15 universities in India and is having high regard for mechanical engineering. The courses offered also attracted me to choose this institution. I took the specialization on the topic of “**Computer Integrated Manufacturing (CIM)**”, the domain I loved the most. After studying about robotics, sensors, composite materials, I developed more interest in this field. My main research area of focus is material science and additive manufacturing. Being a mechanical engineer, passing through all conventional machining and manufacturing stuffs, when I found the giant Fused Deposition Machine (FDM) in the lab and after knowing its working principle and applications, it attracted me to deal with rapid prototyping with the rest of my career. I started my research work with **optimization of process parameters for Selective Laser Sintering (SLS) of metal powder** to achieve better mechanical properties of the 3D printed parts. Later the research work moved to another rapid prototyping technology using 3D printing machine which deals with production of polymer parts. I had modelled and produced 3D printed parts for applications such as drones, aero modelled miniaturized body parts, and finally a 3D printed bionic arm for biomedical applications.

Another research area in which I am passionate about is material science. Different materials with wide variety of properties and applications plays a vital role in making our world smarter. Ferrous metals are widely used for its easy availability and low cost. At the same time, it tends to react with atmospheric oxygen and here corrosion begins. Two years of industrial experience in the field of corrosion enabled me to understand about the nature of the material and its reaction with atmosphere. I had dealt with corrosion prevention techniques using suitable surface treatment techniques. Corrosion prevention with coatings, thin films and bio-fluids are the areas of my current research. After I have completed my Master’s degree with First class, I started my career as an assistant professor. In my teaching career, I have some research exposure in Rapid prototyping tools **such as SLS, FDM, SLA, 3D printer** enabled to manufacture metal / polymer-based products for Bio-medical, aeromodelling applications. I have done projects in powder metallurgy, Composite Materials, Additive Manufacturing, Material characterization and testing. Later, I took a break for a personal mission to East Timor as a volunteer with international movement I restarted my career more into material science and behavior and it was almost 2 years. Especially with material reactions with environment and corrosion engineering, which yields mere knowledge about metals in different industries for different applications like automotive, power plant, aerospace, etc.

So far, I have been involved in metal powder based additive manufacturing, AL/SiCp powder based composite gear produced by stir casting and powder metallurgy, reinforcing Carbon Fiber and by employing Bio-inspired interlock sutures, low cost –light weighted 3D bionic arm. I have written 5 international journals out of which; 1 journal is published. 1 journal is accepted for publication. 1 journal is under review. 2 journals are communicated to respective journals. The details and abstract of my research journals are as following:

Research publications

1. **Ruban W, Vijayakumar V, Dhanabal P, Pridhar T** “Effective process parameters in Selective Laser Sintering” published in *International Journal on Rapid Manufacturing*, 2014, Inderscience.

Abstract: Selective laser sintering (SLS) is a powder-based rapid prototyping (RP) technology in which parts is built by CO2 laser. This research work presents an optimal method to determine the best processing parameter for SLS in order to fabricate parts with enhanced component integrity and reduced overall costs using stainless steel material. Moreover, the optimum process parameters, such as layer thickness, hatch spacing, laser power and part bed temperature are obtained by adopting the Taguchi method based on the Design of Experiment model for better surface finish, dimensional accuracy and hardness. Experiments are planned by using Taguchi’s L12 orthogonal array. The level of importance of the process parameters are determined by using analysis of variance (ANOVA). The experimental results confirmed that the validity of the used Taguchi method for enhancing the SLS performance and optimizing the process parameters in the stainless-steel material based SLS rapid manufacturing process.

This paper is a revised and expanded version of a paper entitled ‘Effective Process Parameters in Selective Laser Sintering’ presented at **International Colloquium on Materials, Manufacturing and Metrology, Indian Institute of Technology, Madras**, 8–9 August, 2014.

2. **Arivazhagan S, Suresh M, Ruban W**, “Strength improvement of Additive Manufacturing components by reinforcing Carbon Fiber and by employing Bio-inspired interlock sutures”, *Journal of Vinyl and Additive Technology*, John Wiley and Sons publishers, 2020

Abstract: The additive manufacturing techniques of Rapid Prototyping (RP) process is used to build Three Dimensional (3D) printed components by depositing layers of materials one over another until it completes. In general, the strength and rigidity of RP processed specimens have a greater potential in nature as there are numerous ways to improve the strength and rigidity of RP processed specimens. This work shows an effective method to improve the strength of 3d printed component joints by reinforcing Carbon Fiber with PLA and applying bio-inspired interlock sutures. The strength of 3D printed components is highly influenced by parameters such as printing speed, extruder temperature and layer thickness. In this concern, the Design Of Experiment (DOE) was performed to ensure the effect of process parameters. The specimens were fabricated according to DOE in order to characterize bending behavior which was analyzed using special fixture. With regard to bending analysis the bending strength and fracture behavior of bio-inspired specimen for three different interlock joints were studied. The analytical technique of Particle Swarm Optimization (PSO) was adopted to predict the optimum printing parameters to improve the bending strength of the 3D printed components. The result shows that Carbon Fiber Reinforced PLA with spline interlock suture increases the bending strength of the 3D printed components when compare to pure PLA.

3. R. Srinivasan, T. Pridhar, L.S. Ramprasath, N. Sree Charan, W. Ruban, "Prediction of tensile strength in FDM printed ABS parts using response surface methodology (RSM)" Materials Today: Proceedings , 2020

Abstract

Additive manufacturing (AM) is used for highly complex structures that can be stable and extremely light weight. AM also enables a design-driven manufacturing process where production is determined by design. Fused deposition modelling (FDM) is one of the mainly used AM technique. It is more easily accessible technique than others and also has advantages like less time consuming, usage with broad range of materials and lower costs. It is also referred to as 3D printing in which objects are produced layer by layer from a CAD model by depositing a thermoplastic filament. Mechanical properties like tensile strength and hardness plays a vital impact when various process parameters are varied on printed parts for different application. Experimental investigation on the FDM printed parts using acrylonitrile butadiene styrene (ABS) material has been carried out by varying the three process parameters namely Infill density, Infill pattern and Layer thickness. Tensile strength and hardness are utilized as response parameters. Experiments are considered by means of central composite design (CCD)

of response surface methodology (RSM). The optimization has been carried out by desirability analysis. The study reveals that that infill density and layer thickness is most significant factor.

Keywords: Fused deposition modelling (FDM); Desirability analysis; Analysis of variance; Infill pattern; Infill density; Layer thickness

4. R. Srinivasan, W. Ruban, A. Deepanraj, R. Bhuvanesh, T. Bhuvanesh, “Effect on infill density on mechanical properties of PETG part fabricated by fused deposition modelling” Materials Today: Proceedings, 2020

Abstract

Digital manufacturing method, in recent times has gained more interest among researchers from the academic world and manufacturing industry, as it is used to build 3D components. In additive manufacturing (AM) especially Fused Deposition Modelling (FDM) has witnessed a rapid development, is used for manufacturing parts from polymer and plastic materials straight away from a digital file. In FDM parts are made by melting, extruding and depositing layers one over the other. Part complexity does not affect the FDM fabrication but other process parameters namely infill density, layer thickness, raster angle, build orientation, air gap, etc., are taken into consideration for productivity. In this paper a study has been carried out to study the effect of infill density on the tensile strength and surface roughness of the FDM component made of Polyethylene Terephthalate Glycol (PETG) and keeping other parameters as constant. Specimens were printed as per the ASTM standard by varying the above mentioned process parameter. It has been observed that the individual process parameters have a considerable influence on the tensile strength and surface roughness of the PETG FDM fabricated parts.

Passion for the topic of study

Currently my focus is moving to incorporate Process-Structure-Property relationships of additively manufactured metals and material design and characterization of 3D printable of cementitious composite through three main initiatives: (1) fabrication of extrusion based 3D printer and advanced nozzle design (2) Partial replacement of cement with low carbon materials and (3) improving the functional and mechanical properties of printed parts via nanoparticle addition

Investigation into selection of materials, process parameters and properties for Selective Laser Melted parts

1. Study of using different Laser sources for material construction

Selective laser Melting (SLM) is a powder-based rapid prototyping (RP) technology in which parts are built using laser sources (Ex: CO₂ / Nd: YAG laser, fibre laser).

2. Comparative approach with different metals / polymers for bioengineering, tissue engineering.

3. Part built with different Ply orientation

In SLS, the material is formed layer by layer. The different ply orientation of layers results in change of mechanical behaviour of the material.

4. Corrosion behaviour / Mechanical behaviour and characterization of Laser melted produced parts with conventional method produced parts – Comparative approach

I strongly believe that lab in IIT, Guwahati will be ideal platform for me to do fundamental research. I have always loved challenges, and always put myself in more and more unfamiliar, difficult and challenging situations, and successfully completed each of them. Due to my training in additive manufacturing and material science I believe that by pursuing a Doctor of Philosophy degree from in your institute I would be able to pursue my research career in the field that I am keenly interested.

My google scholar citation report is as shown in the following figure.



Ruban Whenish

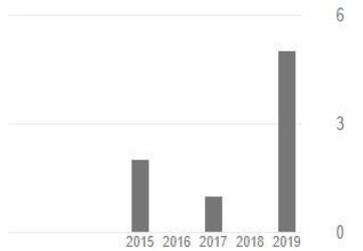
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Additive Manufacturing Optimization composite materials

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Citations	8	8
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PSG College of Technology >

<input type="checkbox"/>	TITLE			CITED BY	YEAR
<input type="checkbox"/>	Effective process parameters in selective laser sintering W Ruban, V Vijayakumar, P Dhanabal, T Pridhar International Journal of Rapid Manufacturing 4 (2-4), 148-164			6	2014
<input type="checkbox"/>	Optimization of process parameters in selective laser sintering W Ruban, V Vijayakumar Rapid Prototyp. J 4 (2-4)			2	2014

Articles 1-2 SHOW MORE

I believe my aptitude for knowledge, with my technical education and industry experience, would make me an apt candidate to pursue research in the field of additive manufacturing for bioengineering and aerospace applications.

Ruban Whenish