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DEVELOPMENT OF FUSION DESIGN CONCEPTS USING STEREOLITHOGRAPHY*

P. Fogarty[1], B. Nelson[1], D. Williamson[1], M. Cole[1]
[1]Oak Ridge National Laboratory, PO Box 2009, Oak Ridge, TN 37831, USA

Stereolithography (SLA) is often considered the pioneer of the Rapid Prototyping industry with the first commercial system introduced in 1988 by 3D Systems. The system consists of an Ultra-Violet Laser, a vat of photo-curable liquid resin, and a controlling system. SLA is excellent for fit and form testing. Material choices include: Flexible, Durable, Rigid, ABS-Like, Water-Clear, High Resolution (Durable & Rigid), & Elastomeric. Parts can also be nickel-plated providing added strength, waterproofing, and electrical conductivity. Rapid metal castings in aluminum, zinc, and magnesium are also available The increasing complexity of fusion devices, particularly stellarators such as QPS (Quasi-Poloidal Stellarator), and NCSX (National Compact Stellarator Experiment) require the use of SLA to provide precise scale models of large components and assemblies, and full scale replicas of parts that are less than 20 cubic inches in size. So far, SLA parts of the complex modular coil windings, shells, vacuum vessel, and conductor leads blocks for NCSX have been made. These parts were invaluable for discovering interferences when components were assembled and showed areas of weakness and thinning of the shell walls. The QPS coil winding configuration was modeled with SLA. The lead winding blocks will possibly be made as SLA parts for the actual finished components if SLA mechanical properties at temperature are shown to be adequate. An SLA model was used to visualize a nozzle system for delivering “FLiBe” salt to continuously refresh the “First Wall” of an advanced reactor concept for the APEX (Advanced Power Extraction) program. It was translucent and all of the internal piping and the flow paths of the nozzles were clearly visible. The model was connected to a water system to demonstrate the flow streams and to show how an overlapping, basket weave pattern formed a shield to protect the nozzle assembly from exposure to a plasma. SLA parts do not require machining, nor programming, they only require a 3D cad model that is exported as an .STL, .WRL, or STEP file that can be sent electronically to an SLA provider. The time required to “grow” a part varies between 1-24 hours. The conductor lead blocks for QPS can be produced as SLA parts from start to delivered finished product in 3-6 days, whereby conventionally machined parts will require drawings, procurement of materials, and shop time scheduling which could end up costing $3,000-$5,000 each and could take over 6 weeks for delivery. On the NCSX project, certain components will be made as SLA parts to be pre-assembled and used as guides for beginning coil winding, and also be used to check the final, conventionally machined parts for accuracy. SLA parts also make fantastic marketing and public relations tools to be able to show anybody what a really complex component looks like in true 3D instead of trying to imagine or guess what it is from looking at a 2-D drawing.

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