

LARGE SCALE REACTIVE ADDITIVE MANUFACTURING AND WHAT TO EXPECT WHEN SCALING UP

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Additive manufacturing as a whole offers tremendous savings in time and cost for rapid prototyping and tooling. At present there is a significant number of thermoplastic printers available from small-scale filament-based extrusion to large scale pellet-based extrusion. Thermosets have seen less growth and have been primarily limited to small scale research setups. Recently, a large-scale thermoset printer, the Reactive Additive Manufacturing (RAM) printer was developed (cf. Figure 1). This printer consists of an overall build volume of 450 ft³ and a gantry speed up to 50 in/s. The RAM system is also equipped with a modular pumping station capable of pumping feedstock material at pressures of 3000 psi in 5 or 55 gallon reservoirs. This work intends to reveal the challenges of working with a large scale Direct Ink Writing (DIW) process and how to overcome them. Two material chemistries have been scaled up for this system and are presented herein: a peroxide cured vinyl ester and latent cured epoxy-anhydrides. Factors such as pumpability, printability, and performance vary significantly between these systems and are discussed using rheological characterization, modeling, printing setup and parameters, and part design.



Figure 1 – The Reactive Additive Manufacturing (RAM) printer produced by Magnum Venus Products in collaboration with Oak Ridge National Laboratory.