# Summary of Liquid Oxygen/Hydrogen, Direct Metal Laser Sintering Injector Testing and Evaluation Effort at Marshall Space Flight Center

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The last several years have witnessed a significant advancement in the area of additive manufacturing technology. One area that has seen substantial expansion in application has been laser sintering (or melting) in a powder bed. This technology is often termed 3D printing or various acronyms that may be industry, process, or company specific. Components manufactured via 3D printing have the potential to significantly reduce development and fabrication time and cost. The usefulness of 3D printed components is influenced by several factors such as material properties and surface roughness. This paper details three injectors that were designed, fabricated, and tested in order to evaluate the utility of 3D printed components for rocket engine applications. The three injectors were tested in a hot-fire environment with chamber pressures of approximately 1400 psia. One injector was a 28 element design printed by Directed Manufacturing. The other two injectors were identical 40 element designs printed by Directed Manufacturing and Solid Concepts. All the injectors were swirl-coaxial designs and were subscale versions of a full-scale injector currently in fabrication. The test and evaluation programs for the 28 element and 40 element injectors provided a substantial amount of data that confirms the feasibility of 3D printed parts for future applications. The operating conditions of previously tested, conventionally manufactured injectors were reproduced in the 28 and 40 element programs in order to contrast the performance of each. Overall, the 3D printed injectors demonstrated comparable performance to the conventionally manufactured units. The design features of the aforementioned injectors can readily be implemented in future applications with a high degree of confidence.

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