Digital Twin Implementation in Additive Manufacturing: A Comprehensive Review	
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Abstract: The additive manufacturing (AM) field is rapidly expanding, attracting significant scientific attention. This family of processes will be widely used in the evolution of Industry 4.0, particularly in the production of customized components. However, as the complexity and variability of additive manufacturing processes increase, there is an increasing need for advanced techniques to ensure quality control, optimize performance, and reduce production costs. Multiple tests are required to optimize processing variables for specific equipment and processes, to achieve optimum processing conditions. The application of digital twins (DTs) has significantly enhanced the field of additive manufacturing. A digital twin, abbreviated as DT, refers to a computer-generated model that accurately depicts a real-world object, system, or process. A DT comprises the complete additive manufacturing process, from the initial conception phase to the final manufacturing phase. It enables the manufacturing process to be continuously monitored, studied, and optimized in real time. DT has emerged as an important tool in the additive manufacturing industry. They allow manufacturers to enhance the process, improve product quality, decrease costs, and accelerate innovation. However, the development of DT in AM is an iterative and continuous process. It requires collaboration between domain experts, data scientists, engineers, and manufacturing teams to guarantee an accurate representation of the process by the digital twin. This paper aims to provide a comprehensive analysis of the current state of DT for additive manufacturing, examining their applications, benefits, challenges, and future directions.

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