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4D printing: Historical evolution, computational insights and emerging applications

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Abstract

Four-dimensional printing (4DP) has gained tremendous interest in the field of materials and manufacturing due to its shape changing properties. Unlike three-dimensional printing (3DP) fabricated with a stationary objects, 4DP allows a 3D printed objects to transform itself to another configuration in response to external energy inputs such as thermal, magnetic, solvent, light or other environmental factors. Utilizing the aforementioned capabilities of 4DP, scientists from various disciplines have investigated a wide range of 4DP with proofs-of-concept. Despite numerous initiatives, 4DP still requires additional developments to meet the industrial applications. This review exercise is therefore aimed to highlight the historical evolution, computational insights and emerging application of 4DP. The review begins by presenting historical evolution and basic fundamental elements of 4DP. The review also presents computational overview on 4DP. Furthermore, different emerging applications of 4DP are highlighted to enlighten the readers. The current challenges of 4DP and future perspectives are critically discussed. Finally, the findings of this review tends to structure research efforts in the next one decade toward the creation of sophisticated 4DP products that will meet the needs of consumers and industry. © 2023 Elsevier B.V.

Author Keywords

3DP; 4DP; Computational insights; Shape memory polymers

Index Keywords

3D printing; 3DP, 4DP, Computational insight, Emerging applications, External energy, Historical evolutions, Property, Shape memory polymers, Stationary objects, Three-dimensional printing (3DP); Shape-memory polymer

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