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REVIEW ARTICLE

A survey of additive manufacturing reviews

Xiaoya Zhai[1], Liuchao Jin[2], Jingchao Jiang[2]*

[1]School of Mathematical Sciences, University of Science and Technology of China, China

[2]Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Shatin, Hong Kong, China

Abstract

Nowadays, additive manufacturing (AM) technologies have been widely used in construction, medical, military, aerospace, fashion, etc. The advantages of AM (e.g., more design freedom, no restriction on the complexity of parts, and rapid prototyping) have attracted a growing number of researchers. Increasing number of papers are published each year. Until now, thousands of review papers have already been published in the field of AM. It is, therefore, perhaps timely to perform a survey on AM review papers so as to provide an overview and guidance for readers to choose their interested reviews on some specific topics. This survey gives detailed analysis on these reviews, divides these reviews into different groups based on the AM techniques and materials used, highlights some important reviews in this area, and provides some discussions and insights.

Keywords: Additive manufacturing; 3D printing; Review

***Corresponding author:**
Jingchao Jiang
(jjia547@aucklanduni.ac.nz)

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1. Introduction

Thirty years into its development, additive manufacturing (AM, also known as 3D printing) has become a mainstream manufacturing process. AM fabricates parts by adding materials layer-by-layer directly based on a 3D model. It is able to manufacture complex parts and allows more freedom of design optimization compared with traditional manufacturing techniques[1]. According to ISO/ASTM, AM can be divided into seven groups: vat photopolymerization, material jetting, binder jetting, powder bed fusion, material extrusion, directed energy deposition, and sheet lamination[2]. AM has its distinctive advantages over conventional manufacturing processes, for example, reduced product development time, lower cost, and ability to fabricate almost any complex shape. Therefore, AM has now been widely used in construction, medical, military, aerospace, fashion, etc. Until now, thousands of review papers have already been published in the field of AM, let alone the published research papers in this field. Figure 1 shows the number of published review papers in AM in each year. As can be seen, there are too many AM review papers published in recent years, with huge increasing rate. It is, therefore, perhaps timely to conduct a survey on AM review papers so as to provide an overview and guidance for readers to choose their interested reviews on some specific topics. This survey gives detailed analysis on these reviews, divides these reviews into different groups, and highlights some important reviews in this area along with discussions.

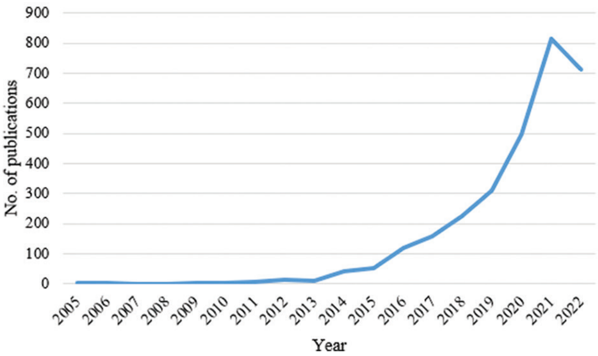

Figure 1. Number of publications of AM review papers in each year (statistics from Scopus database; search keywords: “additive manufacturing” in the title, abstract or keywords, then limited to review; access date: October 19, 2022).

2. Additive manufacturing technologies

This section gives a brief introduction on AM technologies. According to ISO/ASTM[2], AM can be divided into seven categories: (i) Material extrusion, (ii) powder bed fusion, (iii) material jetting, (iv) binder jetting, (v) directed energy deposition, (vi) vat photopolymerization, and (vii) sheet lamination. Each AM technique will be introduced briefly before going into the review papers published in this area.

2.1. Material extrusion

Material extrusion is an AM process that selectively distributes material through nozzles or orifices[3-6]. In 1988, Scott Crump, co-founder of Stratasys Ltd., developed the AM process, which forms a layer by mechanically extruding molten thermoplastic materials (e.g., acrylonitrile butadiene styrene (ABS) and polylactic acid (PLA)) onto the substrate[7]. This AM process was subsequently coined as fused deposition modeling (FDM), which requires a high operating temperature to melt the material[8]. The manufacturing process of FDM starts from a 3D model, which is then translated into gcode data that can be read by FDM machines. After the data is sent to the machine, the machine can manufacture parts in a point-by-point and then layer-by-layer manner, from the bottom of the part to the top, until the whole part is completed. The material (filament) is first melted in the liquefier/extrusion head and then deposited carefully through a nozzle to platform of the printer. The extrusion head moves along the X and Y axes, while the construction platform operates up and down on the Z axis. At present, a lot of materials have been developed for material extrusion AM, including acrylonitrile-butadiene-styrene (ABS), nylon, high impact polystyrene (HIPS), polyethylene terephthalate (PET), polylactic acid (PLA), polyethylene terephthalate glycol (PETG), polyether ether ketone (PEEK), and thermoplastic polyester (TPC). In general, support removal and post-processing may be needed after fabrication[9].

2.2. Powder bed fusion

Powder bed fusion is another AM process. Typically, powder bed fusion selectively melts the powder in the tank using an energy beam (laser or electron)[10]. After scanning and finishing one layer of powder, the rolling mechanism helps spread the next layer of the powder. Then, the next layer is scanned, melted, and fused, until the entire part is completed. In the mid-1980s, Deckard and Beaman developed the polymer powder bed fusion technology, which is used to process polymer powders[11]. Now, more materials can also be used in this technology, such as ceramics or metals[12,13]. Selective laser melting (SLM)[14,15], selective laser sintering (SLS)[16], direct metal laser sintering (DMLS)[17,18], and electron beam melting (EBM)[19] are among the most popular metal powder bed fusion technologies. DMLS and SLM use focused laser beams as power sources[20-22], while EBM uses scanning electron beams (up to 60 kV) as the power source[23]. The actual printing process is completed in a vacuum or inert environment to avoid powder oxidation.

2.3. Material jetting

Material jetting is similar to inkjet printing. Inkjet printing deposits ink droplets onto a substrate drop by drop, while material jetting process directly deposits wax and/or photopolymer droplets onto the substrate by on-demand inkjet[24,25]. Light curing or heating is the driving force of the phase change of the sprayed droplets. A lot of research has been carried out on material jetting, including direct ink jetting of nanoink suspensions of ceramics[26,27], semiconductor[28], and metals[29].

2.4. Binder jetting

In binder jetting, a liquid polymer is selectively deposited onto a bed of powder[30]. The jetted polymer droplet infiltrates the powder surface, leading to a printed powder agglomerate primitive. Powder spreading promotes recoating, as is done in powder bed fusion processes. The finished parts are composed of bound powder, which requires infiltration through post-processing to gain enough strength. Any powdered material that can be successfully spread and wet by the jetted binder can be used in this technique. Different materials have been studied using this technique, for example, foundry sand[31], metal[32], polymer materials[33], and ceramic[34]. The binding mechanism of this technique is chemical and/or thermal reaction bonding. Depending on the bonding agent, chemical reaction is generally the source of activation. After completing the fabrication, post-processing may be necessary, including removal of loose powder and impregnation/infiltration of suitable liquid material depending on the powder material and intended application.

2.5. Directed energy deposition

In directed energy deposition (DED), metallic powder or wire is fed directly into the focal point of an energy beam to create a molten pool[35]. Laser Engineered Net Shaping (LENS), belonging to DED, was first developed at Sandia National Laboratories in 1995 and commercialized by Optomec[36]. Parts printed by LENS accommodate graded multi-materials[37] and allow microstructures with complex inner features[38]. DED systems with wire-fed methods have been achieved[39], and DED of powder directly has also been successful[40,41]. Lasers and electron beams are the most commonly used energy source.

2.6. Vat photopolymerization

The definition of Vat photopolymerization is an "additive manufacturing process in which liquid photopolymer in a vat is selectively cured by light-activated polymerization"[2]. Vat photopolymerization uses a (liquid) photopolymer resin which is able to cure (solidify) under a light source[42,43]. Stereolithography (SLA) and digital light processing (DLP) are the most used techniques which belong to Vat photopolymerization. The scanning speed of vat photopolymerization is relatively high and minimum layer thickness is adjustable depending on the curing depth[44]. Once finishing the printing, post-processing may be needed, for example, support material removal and/or post-curing by further UV exposure.

2.7. Sheet lamination

Sheet lamination is an AM process in which sheets of material are bonded to form a part[45]. The process works by scrubbing each layer together with pressure and/or binders continuously. In this technique, the raw material typically is paper, metal foil, polymers or composite sheets predominately formed of metal, or ceramic powder material. Thermal reaction, chemical reaction bonding, or ultrasound can be used for binding. The source of activation includes localized or large-scale heating, chemical reaction, and ultrasonic transducers.

3. Analysis and discussion of AM review papers

This section gives the detailed analysis of review papers published within the field of AM. Top authors, source journals, affiliations of authors, and countries, are discussed. Then, the review papers are analyzed and discussed based on their different focuses, for example, different AM techniques (as briefly introduced in the previous section) and materials used. The database used is Scopus. Scopus is one of the most used databases, and it includes more papers than the Web of science.

3.1. Top 10 authors

As shown in Figure 2, Ramakrishna Seeram from National University of Singapore has the most review papers (21) published within AM field, followed by Chua Chee Kai from Singapore University of Technology and Design, and Yeong Wai Yee from Nanyang Technological University. It is interesting that all the top three authors are from Singapore. Researchers may refer their publications to catch up the up-to-date research in the AM field.

3.2. Top ten journals

Looking at the sources of these review papers (Figure 3), most of these AM review papers are published in journal *Additive Manufacturing*, followed by *Materials* and *International Journal of Advanced Manufacturing Technology*. Researchers may check these journals' websites to see the state-of-the-art developments of AM technologies.

3.3. Top 10 affiliations

As shown in Figure 4, most of the review papers in additive manufacturing are from Nanyang Technological University, followed by Singapore Centre for 3D Printing.

3.4. Top ten countries

Looking at the countries of the authors from, United States has the most review papers in AM, with 756 review papers published, followed by China with 617 publications (Figure 5).

3.5. Review papers in the seven AM techniques

Dividing these review papers into the seven AM techniques as introduced in section 2, it can be found that most review papers are about powder bed fusion, and no review paper is found in sheet lamination (Figure 6). This is probably because powder bed fusion is the most focused research area within AM, due to its application potential in aerospace, engineering, and biomedicine. While, sheet lamination seems a little bit out of focus at this moment. Note that, the review papers collected in this subsection only consider the broad review in these seven AM techniques, excluding the review papers focused on a specific topic (e.g., process parameters' influence, fatigue analysis, and path planning). For the broad reviews in these seven AM techniques, the most cited papers are listed in Table 1. Readers can check these papers based on their interests. Table 2 gives more review papers focusing on the specific topics in each AM technique. For example, Nohut and Schwentenwein[46] focuses on functionally graded materials in vat photopolymerization, while Xu *et al.*[47] focuses on drug

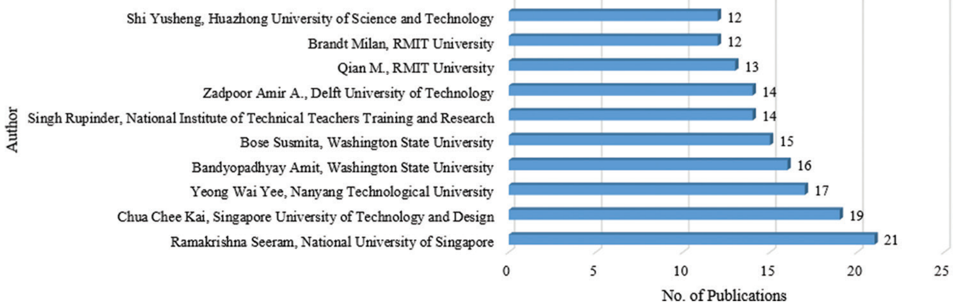

Figure 2. Top ten authors of AM review papers (statistics from Scopus database; search keywords: "additive manufacturing" in the title, abstract or keywords, then limited to review; access date: October 19, 2022).

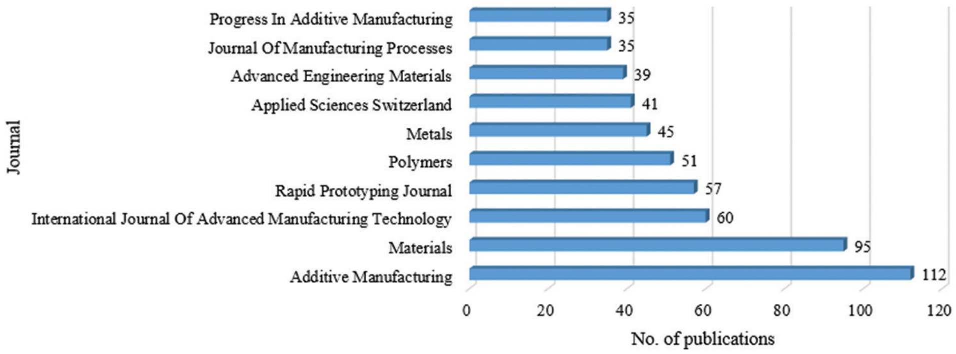

Figure 3. Top ten journals of AM review papers published in (statistics from Scopus database; search keywords: "additive manufacturing" in the title, abstract or keywords, then limited to review; access date: October 19, 2022).

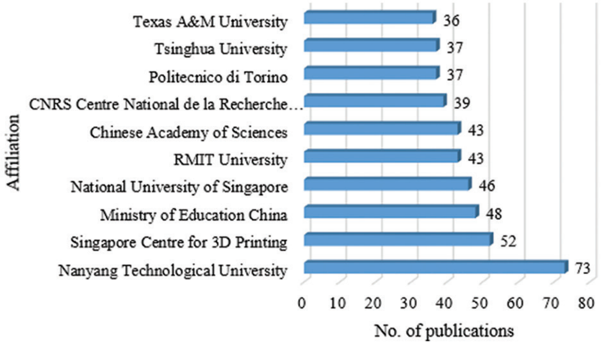

Figure 4. Top ten affiliations of authors of AM review papers (statistics from Scopus database; search keywords: "additive manufacturing" in the title, abstract or keywords, then limited to review; access date: October 19, 2022).

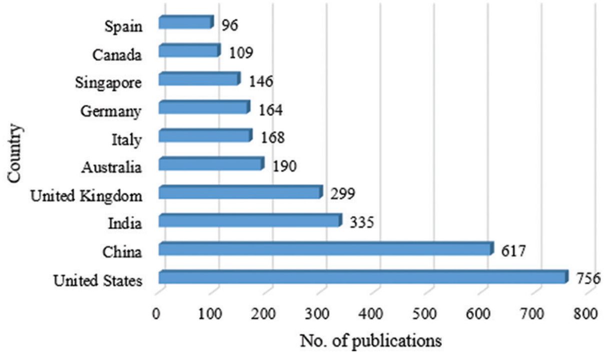

Figure 5. Top ten countries of authors of AM review papers (statistics from Scopus database; search keywords: "additive manufacturing" in the title, abstract or keywords, then limited to review; access date: October 19, 2022).

delivery and medical device in Vat photopolymerization. In terms of powder bed fusion, Luo and Zhao[48] focuses on thermal stress, while McCann *et al.*[49] focuses on process monitoring and machine control. More details on the topics these review papers focus on are shown in Table 2.

3.6. Review paper categories based on materials

From the point view of materials, there are also various review papers in additive manufacturing focusing on different materials. In this survey, the materials are categorized into ten groups, including metal, ceramic, polymer, biomaterial, concrete, fiber, food, smart material, glass, and wood for AM. As shown in Figure 7, most review papers revolve around polymer and metal. This is probably because both polymer and metal are the most commonly used materials and have already been studied a lot. Table 3 lists the most cited review papers in each type of material. Table 4 presents more review papers in

Table 1. Top cited review papers in the seven AM categories

Category	First author	Published year	Article title	No. of citations	References
Material extrusion	Wickramasinghe *et al.*	2020	FDM-Based 3D printing of polymer and associated composite: A review on mechanical properties, defects and treatments	199	[50]
	Dey and Yodo	2019	A systematic survey of FDM process parameter optimization and their influence on part characteristics	173	[51]
Binder jetting	Ziaee and Crane	2019	Binder jetting: A review of process, materials, and methods	221	[52]
Vat photopolymerization	Pagac *et al.*	2021	A review of vat photopolymerization technology: Materials, applications, challenges, and future trends of 3d printing	74	[53]
Material jetting	Gülcan *et al.*	2021	The state of the art of material jetting-a critical review	18	[54]
Powder bed fusion	Grasso and Colosimo	2017	Process defects and *in situ* monitoring methods in metal powder bed fusion: A review	384	[55]
Directed energy deposition	Dass and Moridi	2019	State of the art in directed energy deposition: From additive manufacturing to materials design	150	[56]
	Ahn	2021	Directed Energy Deposition (DED) Process: State of the Art	44	[57]

Statistics from Scopus database; access date: October 19, 2022

Table 2. AM review papers with different topics in each AM technique

Category	Keywords	Article title	First author	References
Vat photopolymerization	Tissue scaffolds	A review on fabricating tissue scaffolds using vat photopolymerization	Chartrain *et al.*	[58]
	Drug delivery; medical device	Vat photopolymerization 3D printing for advanced drug delivery and medical device applications	Xu *et al.*	[47]
	4D printing	4D printing materials for vat photopolymerization	Andreu *et al.*	[59]
	Functionally graded materials	Vat Photopolymerization Additive Manufacturing of Functionally Graded Materials: A Review	Nohut and Schwentenwein	[46]
	Shape-conformable batteries	Toward High Resolution 3D Printing of Shape-Conformable Batteries via Vat Photopolymerization: Review and Perspective	Maurel *et al.*	[60]
	Functional materials	A Review of Multi-Material 3D Printing of Functional Materials via Vat Photopolymerization	Shaukat *et al.*	[61]
Powder bed fusion	Residual stress	An overview of residual stresses in metal powder bed fusion	Bartlett *et al.*	[62]
	Thermal stress	A survey of finite element analysis of temperature and thermal stress fields in powder bed fusion Additive Manufacturing	Luo and Zhao	[48]
	Process physics; material screening	A review of the process physics and material screening methods for polymer powder bed fusion additive manufacturing	Chatham *et al.*	[63]
	Aluminum alloys	New aluminum alloys specifically designed for laser powder bed fusion: A review	Aversa *et al.*	[64]
	Repeatability; reproducibility	A review of critical repeatability and reproducibility issues in powder bed fusion	Dowling *et al.*	[65]
	Formation and impact of flaws	Invited Review Article: Review of the formation and impact of flaws in powder bed fusion additive manufacturing	Snow *et al.*	[66]

(Contd...)

Table 2. ***(Continued)***

Category	Keywords	Article title	First author	References
	drug delivery; healthcare	Advances in powder bed fusion 3D printing in drug delivery and healthcare	Awad *et al.*	[67]
	Process monitoring; machine control	In-situ sensing, process monitoring and machine control in Laser Powder Bed Fusion: A review	McCann *et al.*	[49]
Binder jetting	Stainless steel	A review on binder jet additive manufacturing of 316L stainless steel	Mirzababaei and Pasebani	[68]
Material extrusion	Process–Structure–Properties	Process–Structure–Properties in Polymer Additive Manufacturing via Material Extrusion: A Review	Goh *et al.*	[69]
	Dimensional inaccuracy; warpage	Material extrusion-based additive manufacturing of polypropylene: A review on how to improve dimensional inaccuracy and warpage	Spoerk *et al.*	[70]
	Fiber-reinforced polymers	Fused filament fabrication of fiber-reinforced polymers: A review	Brenken *et al.*	[71]
	Plant biopolymers	Material extrusion of plant biopolymers: Opportunities & challenges for 3D printing	Chaunier *et al.*	[72]
	Design methods	A survey of design methods for material extrusion polymer 3D printing	Huang *et al.*	[73]
	Continuous fiber	Material extrusion additive manufacturing of continuous fiber reinforced polymer matrix composites: A review and outlook	Zhuo *et al.*	[5]
	Wood; lignocellulosic	Material extrusion additive manufacturing of wood and lignocellulosic filled composites	Lamm *et al.*	[74]
	Process monitoring	Process monitoring for material extrusion additive manufacturing: a state-of-the-art review	Oleff *et al.*	[75]
	Plant protein	Plant protein in material extrusion 3D printing: Formation, plasticization, prospects, and challenges	Rowat *et al.*	[76]
Directed energy deposition	Repair	Application of directed energy deposition-based additive manufacturing in repair	Saboori *et al.*	[77]
	In situ monitoring	A review on *in situ* monitoring technology for directed energy deposition of metals	Tang *et al.*	[78]
	Slicing	A review of slicing methods for directed energy deposition based additive manufacturing	Xu *et al.*	[79]
	Adaptive control	Review on adaptive control of laser-directed energy deposition	Wang *et al.*	[80]
	High-quality	Preventing evaporation products for high-quality metal film in directed energy deposition: A review	Kim *et al.*	[81]
	Process parameters; Ti	Selective laser manufacturing of Ti-based alloys and composites: impact of process parameters, application trends, and future prospects	Singh *et al.*	[82]
	Heat treatments; quality; residual stress	A review of heat treatments on improving the quality and residual stresses of the Ti–6Al–4V parts produced by additive manufacturing	Teixeira *et al.*	[83]

Statistics from Scopus database; access date: October 19, 2022

AM, focusing on different materials. We have concluded and listed some of the typical review papers in different materials. For the category of materials in Table 4, ABS, PLA, and PEEK are listed separately as these three types of materials are widely used nowadays and there are a lot of published review papers on these three materials. Note that not all review papers are listed in this table as there are too many papers published nowadays. However, Tables 3 and 4 should be enough for readers to obtain the essential information.

Table 3. Top cited review papers in different materials

Category	First author	Published year	Article title	No. of citations	Reference
Metal	Frazier	2014	Metal additive manufacturing: A review	3289	[84]
	Sames *et al.*	2016	The metallurgy and processing science of metal additive manufacturing	1320	[85]
Ceramics	Deckers *et al.*	2014	Additive manufacturing of ceramics: A review	294	[86]
	Sing *et al.*	2017	Direct selective laser sintering and melting of ceramics: A review	197	[87]
Polymer	Ligon *et al.*	2017	Polymers for 3D printing and customized additive manufacturing	1626	[88]
Stainless steel	Kong *et al.*	2021	About metastable cellular structure in additively manufactured austenitic stainless steels	92	[89]
	Jin *et al.*	2020	Wire arc additive manufacturing of stainless steels: A review	83	[90]
Ni-based alloys	Attallah *et al.*	2016	Additive manufacturing of Ni-based super alloys: The outstanding issues	130	[91]
Ti-based alloys	Shipley *et al.*	2018	Optimization of process parameters to address fundamental challenges during selective laser melting of Ti-6Al-4V: A review	273	[92]
Biomaterial	Murphy and Atala	2014	3D bioprinting of tissues and organs	3847	[93]
Concrete	Buswell *et al.*	2018	3D printing using concrete extrusion: A roadmap for research	557	[94]
Fibre	Parandoush and Lin	2017	A review on additive manufacturing of polymer-fiber composites	581	[95]
	Kabir *et al.*	2020	A critical review on 3D printed continuous fiber-reinforced composites: History, mechanism, materials and properties	176	[4]
Multi-material	Bandyopadhyay and Heer	2018	Additive manufacturing of multi-material structures	349	[96]
ABS	Torrado Perez *et al.*	2014	Fracture surface analysis of 3D-printed tensile specimens of novel ABS-based materials	285	[97]
PLA	Ilyas *et al.*	2021	Polylactic acid (Pla) biocomposite: Processing, additive manufacturing and advanced applications	73	[98]
PEEK	Zanjanijam *et al.*	2020	Fused filament fabrication of peek: A review of process-structure-property relationships	54	[99]
Aluminium alloys	Aboulkhair *et al.*	2019	3D printing of aluminum alloys: Additive Manufacturing of aluminum alloys using selective laser melting	507	[100]
Copper	Tran *et al.*	2019	3D printing of highly pure copper	83	[101]
Food	Godoi *et al.*	2016	3d printing technologies applied for food design: Status and prospects	424	[102]
Smart Material	Mendes-Felipe *et al.*	2019	State-of-the-art and future challenges of UV curable polymer-based smart materials for printing technologies	128	[103]
Glass	Zhang *et al.*	2021	3D printing of glass by additive manufacturing techniques: a review	16	[104]
Wood	Lamm *et al.*	2020	Material extrusion additive manufacturing of wood and lignocellulosic filled composites	21	[74]

Statistics from Scopus database; access date: October 19, 2022

3.7. Review paper categories based on research area

In this section, AM review papers that focus on key/hottest areas (e.g., aerospace, tissue engineering) will be discussed. Nowadays, AM is widely used in different fields, including aerospace, tissue engineering, construction, drug delivery, topology optimization, etc. The most cited review papers focused on these areas are provided in this subsection, as shown in Table 5.

Table 4. Typical review papers in different materials

Category	Keywords	Article title	First author	Reference
Metal	Aerospace	A review on metal additive manufacturing for intricately shaped aerospace components	Madhavadas *et al.*	[105]
	Hybrid FDM	Additive manufacturing of metals and ceramics using hybrid fused filament fabrication	Ramkumar and Rijwani	[106]
	Defects	Multi-scale defects in powder-based additively manufactured metals and alloys	Fu *et al.*	[107]
	Symmetry	Symmetry and its application in metal additive manufacturing (MAM)	Uralde *et al.*	[108]
	Properties	Influence of powder characteristics on properties of parts manufactured by metal additive manufacturing	Muthuswamy	[109]
	Digital twin	A digital twin hierarchy for metal additive manufacturing	Phua *et al.*	[110]
	Modeling; simulation	Modeling and simulation of metal selective laser melting process: A critical review	Zhou *et al.*	[111]
	Hybrid AM	Metal hybrid additive manufacturing: state-of-the-art	Sefene *et al.*	[112]
	Functionally Graded Materials	Review of additive manufacturing techniques for large-scale metal functionally graded materials	Zhang *et al.*	[113]
	Electro polishing	Review-electro polishing of additive manufactured metal parts	Chaghazardi and Wüthrich	[114]
	Defects; anomalies	Defects and anomalies in powder bed fusion metal additive manufacturing	Mostafaei *et al.*	[115]
	Fatigue	Ultrasonic fatigue of laser beam powder bed fused metals: A state-of-the-art review	Avateffazeli and Haghshenas	[116]
	Machine learning; defect detection	Machine learning algorithms for defect detection in metal laser-based additive manufacturing: A review	Fu *et al.*	[117]
	Microstructure	Additive manufacturing of metals: Microstructure evolution and multistage control	Liu *et al.*	[118]
	Electrical Machines	Metal additive manufacturing for electrical machines: Technology review and latest advancements	Selema *et al.*	[119]
	Surface characteristics	Surface characteristics improvement methods for metal additively manufactured parts: A review	Hashmi *et al.*	[120]
	Load-Bearing Implants	Metal additive manufacturing for load-bearing implants	Bandyopadhyay and Heer	[121]
	Mirror	Design and fabrication technology of metal mirrors based on additive manufacturing: A review	Zhang *et al.*	[122]
	In situ monitoring	In-situ measurement and monitoring methods for metal powder bed fusion: An updated review	Grasso and Colosimo	[123]
	Fracture; fatigue	Fracture and fatigue in additively manufactured metals	Becker *et al.*	[124]
	AI; machine learning	Applications of artificial intelligence and machine learning in metal additive manufacturing	Ladani	[125]
	Digital twin	The case for digital twins in metal additive manufacturing	Gunasegaram *et al.*	[126]
	Surface finish; porosity; residual stresses; fatigue	Effects of post-processing on the surface finish, porosity, residual stresses, and fatigue performance of additive manufactured metals: A review	Ye *et al.*	[127]
	Biomedical	Biomedical applications of metal 3D printing	Velásquez-García and Kornbluth	[128]
	Renewable energy	3D printing of metal-based materials for renewable energy applications	Mooraj *et al.*	[129]
	Liquid metal	Current status of liquid metal printing	Ansell	[130]
	Machine learning	Perspectives of using machine learning in laser powder bed fusion for metal additive manufacturing	Sing *et al.*	[131]

(Contd...)

Table 4. ***(Continued)***

Category	Keywords	Article title	First author	Reference
Ceramic	Dental	Additive manufacturing of ceramics for dental applications: A review	Galante *et al.*	[132]
	Bone tissue	3D printing of ceramic-based scaffolds for bone tissue engineering: An overview	Du *et al.*	[133]
	SiC ceramic	Progress and challenges toward additive manufacturing of SiC ceramic	He *et al.*	[134]
	Graphene	Direct ink writing technology (3d printing) of graphene-based ceramic nanocomposites: A review	Pinargote *et al.*	[135]
	Ceramic membrane	A comprehensive review of recent developments in 3D printing technique for ceramic membrane fabrication for water purification	Dommati *et al.*	[136]
	Cellular ceramic	Cellular ceramic architectures produced by hybrid additive manufacturing: A review on the evolution of their design	Pelanconi *et al.*	[137]
Polymer	Mechanical	Mechanical characterization of 3D-printed polymers	Dizon *et al.*	[138]
	Polymer-fiber	A review on additive manufacturing of polymer-fiber composites	Parandoush and Lin	[95]
	Nanocomposites	High performance polymer nanocomposites for additive manufacturing applications	De Leon *et al.*	[139]
		3D printing of polymer nanocomposites via stereolithography	Manapat *et al.*	[140]
	Natural fiber	Additive manufacturing of natural fiber reinforced polymer composites: Processing and prospects	Balla *et al.*	[141]
	Gradient scaffolds	3D printing for the design and fabrication of polymer-based gradient scaffolds	Bracaglia *et al.*	[142]
Stainless steel	Corrosion	Corrosion performance of additively manufactured stainless steel parts: A review	Ettefagh *et al.*	[143]
		The corrosion of stainless steel made by additive manufacturing: A review	Ko *et al.*	[144]
	Mechanical; thermal	Mechanical and thermal properties of stainless steel parts, manufactured by various technologies, in relation to their microstructure	Eshkabilov *et al.*	[145]
	Surface tension	Surface tension measurements of liquid pure iron and 304L stainless steel under different gas mixtures	Klapczynski *et al.*	[146]
	Mechanical; microstructure	Mechanical properties and microstructure of 316 stainless steel processed by pulsed micro-plasma additive manufacturing	Yuan *et al.*	[147]
	Pitting Corrosion	Pitting corrosion in 316L stainless steel fabricated by laser powder bed fusion additive manufacturing: A review and perspective	Voisin *et al.*	[148]
	Powder Reuse	The influence of powder reuse on the properties of laser powder bed-fused stainless steel 316L: A review	Douglas *et al.*	[149]
	Solidification	Solidification behaviour of austenitic stainless steels during welding and directed energy deposition	Hossein Nedjad *et al.*	[150]
Ni-based alloys	Fatigue	Overview: Additive manufacturing enabled accelerated design of Ni-based alloys for improved fatigue life	Shao *et al.*	[151]
	Microstructural constituent	Powder bed fusion additive manufacturing of Ni-based super alloys: A review of the main microstructural constituents and characterization techniques	Haines *et al.*	[152]
	Cracking resistance	Applications of alloy design to cracking resistance of additively manufactured Ni-based alloys	Markanday	[153]
	Residual stress; crack	Additive manufacturing of Ni-based super alloys: Residual stress, mechanisms of crack formation and strategies for crack inhibition	Guo *et al.*	[154]

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Table 4. *(Continued)*

Category	Keywords	Article title	First author	Reference
Ti-based alloys	Mechanical	Additive manufacturing and post-processing of Ti-6Al-4V for superior mechanical properties	Qian *et al.*	[155]
	Fatigue	A review of the as-built SLM Ti-6Al-4V mechanical properties towards achieving fatigue resistant designs	Agius *et al.*	[156]
	Biomedical	A review of powdered additive manufacturing techniques for Ti-6al-4v biomedical applications	Harun *et al.*	[157]
	Chemical polishing	Chemical polishing of scaffolds made of Ti-6Al-7Nb alloy by additive manufacturing	Lyczkowska *et al.*	[158]
	Mechanical	Mechanical properties of titanium-based Ti–6Al–4V alloys manufactured by powder bed additive manufacture	Tong *et al.*	[159]
	Process parameters	Selective laser manufacturing of Ti-based alloys and composites: impact of process parameters, application trends, and future prospects	Singh *et al.*	[82]
	Heat treatment	A review of heat treatments on improving the quality and residual stresses of the Ti–6Al–4V parts produced by additive manufacturing	Teixeira *et al.*	[83]
	Surface roughness	A review on the influence of process variables on the surface roughness of Ti-6Al-4V by electron beam powder bed fusion	de Campos Carolo and Ordoñez	[160]
Biomaterial	Bioink	Bioink properties before, during and after 3D bioprinting	Hölzl *et al.*	[161]
	Biomedical; tissue	3D bioprinting for biomedical devices and tissue engineering: A review of recent trends and advances	Derakhshanfar *et al.*	[162]
	Printability	Printability and Shape Fidelity of Bioinks in 3D Bioprinting	Schwab *et al.*	[163]
	Cell-Hydrogels	Design and printing strategies in 3D bioprinting of cell-hydrogels: A review	Lee *et al.*	[164]
	Skin	3D bioprinting of skin: A state-of-the-art review on modeling, materials, and processes	Vijayavenkataraman *et al.*	[165]
	Hydrogel	3D bioprinting of photo crosslinkable hydrogel constructs	Pereira *et al.*	[166]
	Cardiac tissue; cell	3D Bioprinting of cardiac tissue and cardiac stem cell therapy	Alonzo *et al.*	[167]
	Machine learning	A perspective on using machine learning in 3D bioprinting	Yu *et al.*	[168]
	Organ	The emergence of 3D bioprinting in organ-on-chip systems	Fetah *et al.*	[169]
	Liver transplantation	Bioprinting for liver transplantation	Kryou *et al.*	[170]
	Process parameters	Effects of processing parameters of 3D bioprinting on the cellular activity of bioinks	Adhikari *et al.*	[171]
Concrete	Simulation	Numerical simulations of concrete processing: From standard formative casting to additive manufacturing	Roussel *et al.*	[172]
	Extrusion-based	Extrusion-based additive manufacturing of concrete products: Revolutionizing and remodeling the construction industry	Valente *et al.*	[173]
	Biomimicry	Biomimicry for 3D concrete printing: A review and perspective	du Plessis *et al.*	[174]
	Functionally graded concrete	On-demand additive manufacturing of functionally graded concrete	Ahmed *et al.*	[175]
Fiber	Carbon fiber	Additively manufactured carbon fiber-reinforced composites: State of the art and perspective	van de Werken *et al.*	[176]
	Natural fiber	Recent advancements of plant-based natural fiber–reinforced composites and their applications	Li *et al.*	[177]
	Mechanical	The mechanical testing and performance analysis of polymer-fiber composites prepared through the additive manufacturing	Shanmugam *et al.*	[178]
	FDM	A review on fiber reinforced composite printing via FFF	Ferreira *et al.*	[179]
	Continuous fiber	Material extrusion additive manufacturing of continuous fiber reinforced polymer matrix composites: A review and outlook	Zhuo *et al.*	[5]

(Contd...)

Table 4. *(Continued)*

Category	Keywords	Article title	First author	Reference
	Process parameter	Influence of process parameters on the properties of additively manufactured fiber-reinforced polymer composite materials: A review	Ramesh *et al.*	[180]
Multi-material	Electronics	3D printing of multilayered and multimaterial electronics: A review	Goh *et al.*	[181]
	Powder bed fusion	Multimaterial powder bed fusion techniques	Mehrpouya *et al.*	[182]
	Direct ink writing	Direct ink writing advances in multi-material structures for a sustainable future	Rocha *et al.*	[183]
	Architecture; construction	Multi-material additive manufacturing in architecture and construction: A review	Pajonk *et al.*	[184]
	Polymer	Advances in polymers based multi-material additive-manufacturing techniques: State-of-art review on properties and applications	García-Collado *et al.*	[185]
	Functional material	A review of multi-material 3D printing of functional materials through vat photopolymerization	Shaukat *et al.*	[61]
ABS	Fracture surface	Fracture surface analysis of 3D-printed tensile specimens of novel ABS-based materials	Torrado Perez	[97]
	FDM	Review of acrylonitrile butadiene styrene in fused filament fabrication: A plastics engineering-focused perspective	Peterson	[186]
PLA	Biocomposite	Polylactic acid (Pla) biocomposite: Processing, additive manufacturing and advanced applications	Ilyas *et al.*	[98]
	Bone repair	Recent progress on 3D-printed polylactic acid and its applications in bone repair	Chen *et al.*	[187]
	4D printing	4D printing of shape memory polylactic acid (PLA)	Mehrpouya *et al.*	[188]
	Process Parameter; Mechanical	The influence of the process parameters on the mechanical properties of PLA specimens produced by fused filament fabrication—A review	Cojocaru *et al.*	[189]
PEEK	Process parameter	An overview on the influence of process parameters through the characteristic of 3D-printed PEEK and PEI parts	El Magri *et al.*	[190]
	FDM	Applications of 3D-printed peek via fused filament fabrication: A systematic review	Dua *et al.*	[191]
Aluminum alloys	Microstructure; mechanical	Microstructure and mechanical property considerations in additive manufacturing of aluminum alloys	Ding *et al.*	[192]
	Mechanical	Mechanical properties of SLM-printed aluminium alloys: A review	Ponnusamy *et al.*	[193]
	Heat treatment	Heat treatment of aluminium alloys produced by laser powder bed fusion: A review	Fiocchi *et al.*	[194]
	WAAM	Challenges associated with the wire arc additive manufacturing (WAAM) of aluminium alloys	Thapliyal	[195]
	Corrosion	Corrosion and corrosion protection of additively manufactured aluminium alloys—a critical review	Revilla *et al.*	[196]
Copper	Pure copper	A review on additive manufacturing of pure copper	Jiang *et al.*	[197]
Food	Functional	Toward the design of functional foods and biobased products by 3D printing: A review	Portanguen *et al.*	[198]
	Plant-based	3D food printing: Applications of plant-based materials in extrusion-based food printing	Wang *et al.*	[199]
	Food material	A review on 3D printable food materials: types and development trends	Li *et al.*	[200]
	4D printing	4D printing: a new approach for food printing; effect of various stimuli on 4D printed food properties. A comprehensive review	Navaf *et al.*	[201]

(Contd...)

Table 4. ***(Continued)***

Category	Keywords	Article title	First author	Reference
Smart materials	Manufacturing	Significant roles of 4D printing using smart materials in the field of manufacturing	Haleem *et al.*	[202]
	Wearable application	Potentials of additive manufacturing with smart materials for chemical biomarkers in wearable applications	Kwon *et al.*	[203]
Glass	Crystallization	Crystallization in additive manufacturing of metallic glasses: A review	Liu *et al.*	[204]
	Silica Glass	Overview of 3D-printed silica glass	Zhang *et al.*	[205]
Wood	Wood powders	A review on wood powders in 3D printing: processes, properties and potential applications	Das *et al.*	[206]

Statistics from Scopus database; access date: October 19, 2022

Table 5. Most cited review papers in key/hottest areas

Area	Article title	Citation	First author	References
Machine learning	Machine learning in additive manufacturing: State-of-the-art and perspectives	153	Wang *et al.*	[207]
Construction	3D printing using concrete extrusion: A roadmap for research	560	Buswell *et al.*	[94]
Biomedical	Bioink properties before, during and after 3D bioprinting	567	Hölzl *et al.*	[161]
Tissue engineering	3D bioprinting of tissues and organs	3872	Murphy and Atala	[93]
Topology optimization	Current and future trends in topology optimization for additive manufacturing	383	Liu *et al.*	[208]
Electrochemical	3D-printing technologies for electrochemical applications	554	Ambrosi and Pumera	[209]
Smart structures	Printing soft matter in three dimensions	838	Truby and Lewis	[210]
Food printing	3D printing technologies applied for food design: Status and prospects	428	Godoi *et al.*	[102]
Drug delivery	3D printing pharmaceuticals: Drug development to frontline care	243	Trenfield *et al.*	[211]
Aerospace	The present and future of additive manufacturing in the aerospace sector: A review of important aspects	279	Uriondo *et al.*	[212]

Statistics from Scopus database; access date: October 19, 2022

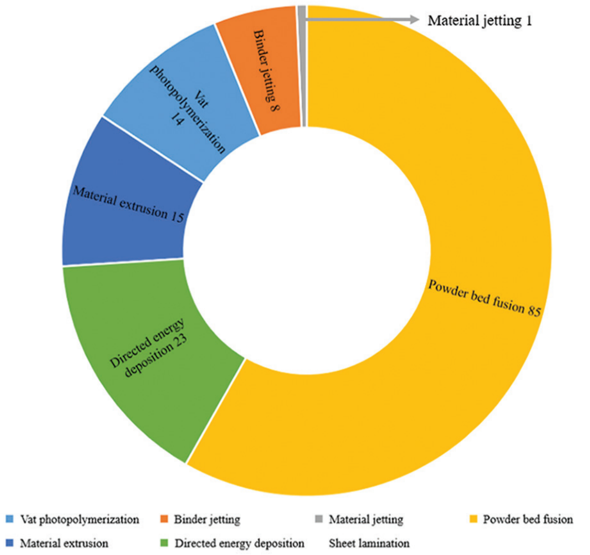

Figure 6. Number of review papers in different AM techniques (statistics from Scopus database; access date: October 19, 2022).

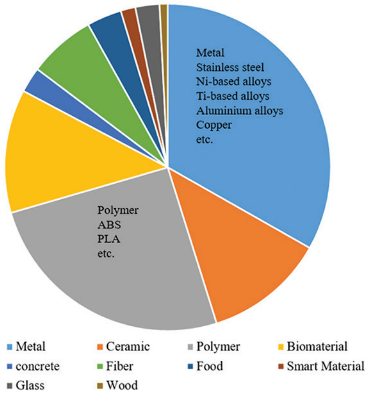

Figure 7. Review papers focusing on different materials (statistics from Scopus database; access date: October 19, 2022).

4. Conclusions

In this work, we conducted a survey on published review papers in AM. Analysis and discussion on reviews in seven AM techniques are given (i.e., material extrusion, powder bed fusion, material jetting, binder jetting, directed energy deposition, vat photopolymerization, and sheet lamination). As can be seen, most of the review papers are in the categories of powder bed fusion and directed energy deposition. No review papers in sheet lamination were found. In the future, it is necessary to carry out a review on sheet lamination, although it is not a famous AM technique. In addition, typical review papers are categorized into different groups based on the materials these review papers focused on (e.g., metal, ceramic, polymer, biomaterial, concrete, fiber, food, smart material, glass, and wood). The specific objectives of each review paper are listed, as shown in Table 4. For example, He *et al.*[134] focuses on SiC ceramic in AM, and readers can refer accordingly based on their interests. The aim of this survey paper is to provide a guidance to the development of AM review papers, give a comprehensive analysis on the current available review papers in this field, and hopefully, provide some insights and inspire more ideas. As the review papers published in AM are increasing; nowadays, the selected review papers in this survey are based on the Scopus database, which might have some limitations. In addition, this survey only considers the most cited papers in each category based on the number of citations, while the published time of the review papers is not considered.

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Conflict of interest

None.

Author contributions

Conceptualization: Jingchao Jiang
Data curation: Liuchao Jin
Formal analysis: Jingchao Jiang
Funding acquisition: Xiaoya Zhai
Investigation: Xiaoya Zhai
Methodology: Jingchao Jiang
Project administration: Xiaoya Zhai
Resources: Xiaoya Zhai
Writing – original draft: Xiaoya Zhai, Liuchao Jin
Writing – review & editing: Jingchao Jiang

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