An Overview of Nano manufacturing with Bibliometric Indicators

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Bibliometric research presented the statistical analysis of publications. The bibliometric method were applied to classify the data regarding to different variables such as journals, authors and countries. The research shows a general overview of studies that have been reported in Nano manufacturing using bibliometric indicators. The main important point is that, these indicators provide the reader with general picture which identify the most influential research on Nano manufacturing. The paper divided into sub-sections which focused on the relevant journals, research papers, authors, institutions and countries. 90% of results were accordance with human thinking, moreover a few unexpected results were appeared. The main objective of this article is to be informative, and the indicators sum up the most essential research in this topic. However, some influential issues will be skipped if they are not included in the web of science database, which is the only source that used to handle the bibliometric analysis.

Keywords*:* Nano manufacturing, bibliometric research, influential authors, influential journals, influential countries

I. INTRODUCTION

Nano-manufacturing is the production of Nano-scale materials, components, structures, systems and devices. The production of parts could be either "bottom up" from nanoscale materials or "top down" which has too many steps for high precision. The production of Nano can be done by different techniques such as etching, laser ablation and others. The necessity of Nano manufacturing is became one of the important techniques to produce a very small particles which could be used in various applications [1]. The needs of Nano manufacturing is not only by the requirement of the devices and structures with new properties but with decreasing the component of size, material applied and consumption of products. Nano-scale manufacture indicates the production of structures, components and materials with dimensions between 1-100 nm which include the surface and sub-surface style, nanowires, 3D Nano structures, nanotubes and nanoparticles. Lasers have been provided a very important opportunities in the inquiries of Nano-manufacturing [2].

Nano manufacturing research has been developed the physical processes to control the technical barriers that block the translation of lab-scale production of Nano-scale materials and structures to industrial-scale manufacturing. Research in scalable Nano manufacturing presented the manufacturability challenges such as reliability, scalability, controllability, yield, efficiency, quality and affordability. Manufacturing challenges fall in two categories desired outcomes and appropriate metrics. The requirements needs are to produce with high quality and durability, manufacturing affordability and scalability, process reliability and repeatability manufacturing efficiency and yield, and production functionality and performance. The precise of placement, overall registration and nanostructure density, type of size and resolution, difficulties and their rates of construction are some of the metrics which should be determined. These are some challenges for any type of manufacturing processes, but more in Nano manufacturing regarding to the measuring, manipulating and controlling at the Nano-scale is not too hard and small errors can result in defect the product. Moreover, a compromise could made to consider a feature size and resolution in the context of processing or forming rates and high volume production[3].

A general review in the Nano manufacturing has been discussed in this research by using bibliometric analysis indicators. The aim of bibliometric analysis indicators is to specify and measure the impact of publications and articles that based on counting the scientific papers published and their citations. Bibliometric indicators are very important to evaluate organizations, authors, institutions, universities and countries to decide the most influence among others. Bibliometric indicators build a general picture of research field.so, there were some that face the research due to some particular research style that constructed by each researcher which guide to various volume of self-citations and co-authored papers[4]. However, too many definitions and explanation have been done on bibliometric in previous articles[5]&[6].In the previous studies a lot of researchers have been presented a bibliometric researches in different fields. The research areas that has been used a bibliometric indicators are Econometrics[7], Ant colony optimization[8], Innovation[9], Probability and statistics[10], Environmental and ecological economics[11], Operations management[12], Productivity in production[13], Entrepreneurship[14], Profiling analysis of pricing research[15], Data envelopment analysis[16], Management[17], Marketing[18], Health[19], Laser sintering [20], Abrasive Water Jet [21], Electron beam melting [22], Grey system[23] and fuzzy systems [4]. However, no bibliometric article has been presented the Nano manufacturing.

The main objective of this study is to highlight the Nano manufacturing researches from the oldest time to the recent of this field by using bibliometric approach .according to the collected data from web of sciences (WOS), the overview of the highest and most influential research will be discussed. The data collected can be arrange as research articles, authors, journals, institutions and countries.

This article is organized as follows: section 2 study methodology, section 3 present the most 50 cited articles in the Nano manufacturing, section 4 discuss the most productive and influential authors. Section 5 come out with the most influential organizations in this Nano manufacturing, section 6 present the most productive countries. Section 7 discuss and sum up the paper.

II. METHODOLOGY

The collected information for Nano manufacturing research has been reported at the Web of Science (WOS) which combine too many databases. WOS almost has articles from all known scientific resources from more than 15,000 journals and 55 million articles. The data has been categorized in 251 topic categories and in 151 areas of study. Other areas than WOS could be consider of collecting information such as google scholar and SCOUPUS. However, at this article WOS has been only used as a source of data collection.

This search is completed in May 2017 and more than 2193 publications were reported by using the keywords in WOS search tap since 1993. More than ten types of publications were reported such as books reviews, journal articles, proceedings, comments, notes, and editorial material. However, the article focused only on the reviews and articles which decrease the number of reported publications from 2193 to 1659 since 1993 to 2017. Nano manufacturing a getting more attention over the las two decades as shown in Figure 1 which present an increasing in the number of publications on Nano manufacturing in the last few years. Mostly around 50% of the papers among the 1659 are from the past decade. This indicates that the research in the Nano manufacturing is getting more attention. The average number of publications per year in the According field are more than 66 with the highest number of publications per year in 2016 and 2015 as 202 and 184 publications respectively. According to the WOS, the average citation of the reported research is also too important. The citation rate is too important to show the significant of research field so it can be classified into different thresholds according to the number of the received citation and it's percentage of the article for each threshold which has been presented in this

research. Form the Table1 presented below, it concluded that a very low percentages with (3) articles have been received more than or equal to 300 citations, 0.4% (6) articles got more than or equal 200 citations, 2% (24) articles got more than or equal 100 citations, 5% (78) articles got more than or equal 50 citations, 17% (281) articles got more than or equal 20 citations, while the rest papers have been received less than 20 citations. However, at overall of citation in Nano manufacturing are somehow developed according to its citations record.

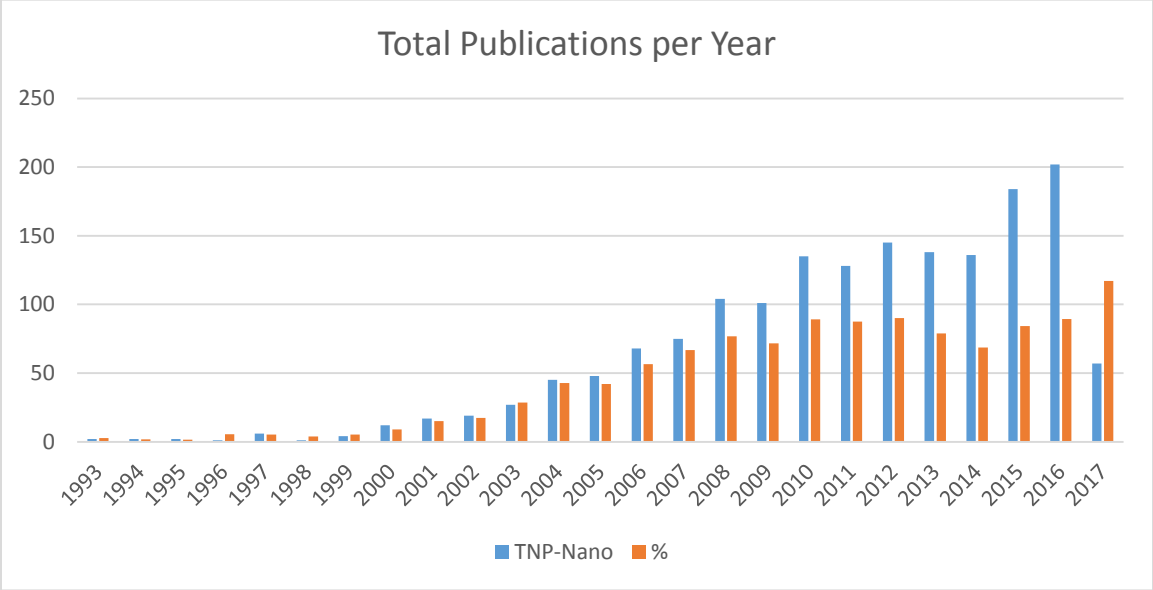


Fig. 1. Number of publications per year in NM research (reviews &articles) from 1985 to 2017. The bars with blue color indicate the total number of NM articles published each year in the web of science and the orange one indicate the ratio (N- NM -P/TNP) × 1,000,000 where N- NM -P is the number of NM papers in year X and TNP is the total number of papers published in the WOS in year X.

Table 1. General citation structure in Nano manufacturing research from WOS.

Number of citations	Number of papers	% Papers
>=300citations	3	0.180832
>=200citations	6	0.361664
>=100 citations	24	1.446655
>=50 citations	78	4.701627
>=20 citations	281	16.93791
< 20citations	1267	76.37131
Total	1659	

The H-index is also called as H-classics [24] which has the ability to analyse the Nano manufacturing research- index applied to measure the importance of articles [25]. To make it clear,

if some papers got an H-index of 60, then 60 of the papers included in these articles have received at least 60 or more citation for each article. For all data collection of papers in Nano manufacturing, the H-index is 67. However, 67 papers have received at least 67 citations. The H-index has been presented by some authors[26].

III. MOST INFLUENTIAL JOURNALS IN NANO MANUFACTURING

The reported journals on Nano manufacturing research are increasing from one year to another. The 50 top most influential journals on Nano manufacturing are presented on Table 2. According to the H-index Classifications the most two influence journals from the 50 are Journal of Nanoparticle Research and Materials Letters. In addition to that, some other journal that consider as the top influential journals such as RSC Advances, Journal of Alloys and Compounds, Ceramics International and so on as shown on table 2. However, some productive journals that are interested in this field such as Materials Research Bulletin, Applied Surface Science and others as presented on the table. The papers quality measured by the impact factor which has been presented on table 2. Moreover, according to the highest number of publication and citation at all field Journal of Nanoparticle Research and Applied Physics Letters. Advanced Materials and Nano Letters have been received the highest impact factor among the top 50 journals presented in the table at all fields. At overall the Applied Physics Letters journal has got the most H-index among the most influential and productive journals in all publications field.

Table 2. Most influential and productive journals in Nano manufacturing research

Rank	Name	TP-Nano	TC-Nano	H-Nano	%P-Nano	TP	TC	H	IF
1	JNR	51	879	17	0.998%	5109	63350	86	2.101
2	ML	37	892	17	0.163%	22700	278146	103	2.437
3	RSCA	34	262	10	0.081%	42050	269868	81	3.289
4	JAC	33	487	13	0.080%	41057	501660	132	3.014
5	CI	32	373	11	0.222%	14431	120321	72	2.758
6	JNN	26	123	5	0.161%	16186	97638	84	1.338
7	JPS	21	493	14	0.089%	23497	683790	227	6.333
8	N	21	289	8	0.143%	14662	303728	149	3.573
9	ACSN	20	825	13	0.201%	9935	461870	241	13.334
10	MRB	20	277	9	0.147%	13622	220882	127	2.435
11	ASSC	18	363	10	0.050%	35835	460185	139	3.15
12	CAMT	17	347	10	0.740%	2297	38434	75	2.492
13	MCP	17	221	10	0.127%	13398	188989	11	2.101
14	JMSET	16	113	6	0.636%	2517	24985	59	1.022
15	JMC	15	793	11	0.089%	16901	672238	230	6.626
16	RMME	14	36	3	0.110%	12761	17679	20	0.236
17	ACSAMI	13	75	6	0.082%	15868	233683	119	7.145
18	AM	13	490	10	0.089%	14526	1137264	386	18.96
19	EACTA	13	184	9	0.043%	30414	693481	201	4.803
20	JMS	13	252	10	0.038%	34070	570655	196	2.302
21	US	13	231	9	0.436%	2979	61589	85	4.556
22	APL	12	168	7	0.010%	117347	3953370	416	3.142
23	AJC	12	18	3	0.081%	14761	19058	24	0.355
24	CEJ	12	175	7	0.092%	13043	246381	129	5.31
25	NL	12	515	9	0.096%	12509	927261	372	13.779
26	NS	11	182	7	0.104%	10561	189992	133	7.76

27	PT	11	144	5	0.100%	11017	160574	105	2.759
28	SR	11	135	5	0.024%	46489	369868	97	5.228
29	CJIC	10	32	3	0.166%	6041	16952	24	0.488
30	EEE-TASE	10	100	5	0.912%	1096	12814	47	2.696
31	IIE-T	10	38	3	0.371%	2696	45334	78	1.463
32	JIM	10	28	3	0.227%	4400	9917	20	0.551
33	CN	9	22	3	0.828%	1087	7035	32	0.934
34	JAST	9	124	7	0.257%	3507	36386	60	0.863
35	JSGST	9	190	6	0.184%	4901	57958	73	1.473
36	TSF	9	168	5	0.022%	40564	646435	182	1.761
37	APMSP	8	86	5	0.057%	13986	198505	134	1.444
38	CP	8	226	7	0.070%	11445	249661	138	4.219
39	IEEE-TN	8	152	6	0.431%	1854	24305	61	1.702
40	JECS	8	180	7	0.082%	9805	180538	111	2.933
41	S	8	516	6	0.149%	5365	188112	168	8.315
42	JCPR	7	33	3	0.334%	2094	5788	23	0.32
43	JMC-A	7	68	5	0.069%	10181	154536	97	8.262
44	JMR	7	122	6	0.058%	12012	256532	155	1.579
45	JPC-C	7	152	5	0.022%	32348	730423	199	4.509
46	JACS	7	59	5	0.026%	26987	681338	227	2.787
47	MSECMBA	7	55	4	0.148%	4745	37846	53	3.42
48	ME	7	83	6	0.065%	10744	92327	77	1.277
49	AFM	6	104	5	0.081%	7372	377515	227	11.382
50	JCS	6	10	2	0.437%	1372	8771	29	1.664

Abbreviations: R, rank; H-PC, H-index with Nano manufacturing only ; TC_PC and TP_PC, total citations and papers only with red; %P-NM, percentage of Nano manufacturing papers in the journal; TP and TC, total papers and citations; IF, impact factor; T50, number of papers in the top 50 list shown in Table 4; H, H-index; JNR, Journal of Nanoparticle Research; ML, Materials Letters; RSCA, RSC Advances; JAC, Journal of Alloys and Compounds; CI, Ceramics International; JNN, Journal of Nanoscience and Nanotechnology; JPS, Journal of Power Sources; N, Nanotechnology; ACSN, ACS Nano; MRB, Materials Research Bulletin; ASSC, Applied Surface Science; CAMT, CIRP Annals Manufacturing Technology; MCP, Materials Chemistry And Physics; JMSET, Journal Of Manufacturing Science And Engineering Transactions Of The ASME; JMC, Journal of Materials Chemistry; RMME, Rare Metal Materials And Engineering; ACSAMI, ACS Applied Materials Interfaces; AM, Advanced Materials; EACTA, Electrochimica ACTA; JMS, Journal of Materials Science; US, Ultrasonics Sonochemistry; APL, Applied Physics Letters; AJC, Asian Journal of Chemistry; CEJ, Chemical Engineering Journal; NL, Nano Letters; NS, Nanoscale; PT, Powder Technology; SR, Scientific Reports; CJIC, Chinese Journal Of Inorganic Chemistry; EEE-TASE, IEEE Transactions on Automation Science And Engineering; IIE-T, IIE Transactions; JIM, Journal of Inorganic Materials; CN, Current Nanoscience; JAST, Journal of Adhesion Science and Technology; JSGST, Journal of Sol Gel Science and Technology; TSF, Thin Solid Films; APMSP, Applied Physics a Materials Science Processing; CP, Carbohydrate Polymers; IEEE-TN, IEEE Transactions on Nanotechnology; JECS, Journal of The European Ceramic Society; S, Small; JCPR, Journal of Ceramic Processing Research; JMC-A, Journal of Materials Chemistry A; JMR, Journal of Materials Research; JPC-C, Journal of Physical Chemistry C; JACS, Journal of The American Ceramic Society; MSECMBA, Materials Science Engineering C Materials for Biological Applications; ME, Microelectronic Engineering; AFM, Advanced Functional Materials; JCS, Journal of Cluster Science.

Table 3. The Impact factor in Nano manufacturing research.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TP	75	104	101	135	128	145	138	136	184	204
TC	3365	2115	2703	2622	1867	1963	1790	1437	980	534
TC2	299	423	179	571	719	677	725	934	1037	1203
TP2	116	143	487	205	236	263	273	283	274	320
IF	2.58	2.96	0.368	2.785	3.047	2.574	2.656	3.3	3.785	3.759

Abbreviations: TP, total published papers per year n; TC, total citations received from articles published in year n; TC2, all citations received in year n – 1 and n − 2 from year n; TP2, total published papers per year n − 1 and n − 2; IF, impact factor of year.

The impact factor is just an indicator which show the publication's value that could be calculated by dividing the number of citations received in the last two years (i.e. n − 1 and n – 2) from year n by the total papers reported in the last two years (n − 1 and n – 2).

The impact factor for all papers yearly publication on Nano manufacturing are presented in Table 3. The table illustrate that, the impact factor increased from one year to another except some few years which get less than its previous years such as 2010 & 2013 as presented in figure 2. In general, the Nano manufacturing got more attention in the last 10 years due to the increasing of impact factor. There are Some critics who are not agree with impact factor calculations due to the manipulation and general result because they are using the self-citations [27],29]. However, some = studies has been reported this kind of problems and some new technique that deal with impact factor calculations [6].

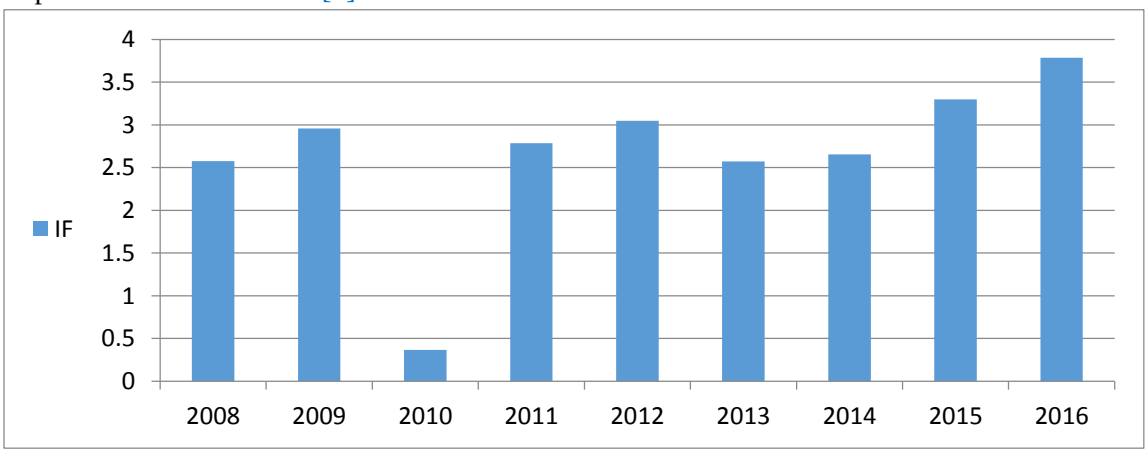


Figure. 2. Impact factor for the last 10 years NM (articles + reviews) since 2008

IV. AN OVERVIEW OF THE MOST PRODUCTIVE AND INFLUENTIAL AUTHORS

So many contributions have been done by authors in Nano manufacturing research. Table 4 presents the top 25 authors with highest number of publications in Nano manufacturing. The publications number are just an indicative only because so many factors could be consider such as, co-authorship, paper size, and journal quality. According to the table, BENELLI G is the highest author who has published in electron beam melting with 27 papers, next is WANG L (18 papers), MONTAZER M (15 papers, and so on for the rest authors as shown in Table 4. The table also presents the most influential authors Nano manufacturing according to the total citations, BENELLI G is the most influential author in Nano manufacturing with more than 388 citations, followed by KIM J who is also received more than 318citations in this field.

Table 4: The most influential authors in in Nano manufacturing research

R	Name	Country	TP-F	TC-F	H-F	H	TP10	TC10	TP	TC
1	BENELLI G	ITALY	27	388	10	26	12	371	150	2,579
2	WANG L	PEOPLES R CHINA	18	254	9	22	14	205	100	1,767
3	MONTAZER M	IRAN	15	274	9	28	5	135	184	3,230
4	MURUGAN K	ITALY	14	168	6	25	6	163	134	1,921
5	LEE JH	SOUTH KOREA	12	223	8	19	9	169	36	994
6	NICOLETTI M	ITALY	11	156	5	25	6	151	172	2,076
7	PANNEERSELVAM C	ITALY	11	154	5	21	5	151	49	989
8	KIM J	SOUTH KOREA	10	318	8	15	7	292	51	853
9	GOVINDARAJAN M	ITALY	9	50	5	22	9	50	80	1,293
10	HUANG Q	USA	9	37	4	11	9	37	43	472
11	LIU Y	PEOPLES R CHINA	9	40	3	14	8	37	125	730
12	MISHRA S	INDIA	9	174	7	13	6	81	66	643
13	WANG X	PEOPLES R CHINA	9	37	4	7	6	29	19	29
14	CETINKAYA C	USA	8	116	6	15	1	5	81	753
15	DINESH D	ITALY	8	153	5	17	5	151	36	713
16	LI J	PEOPLES R CHINA	8	22	1	21	8	22	116	1,377
17	MORSALI A	IRAN	8	115	6	43	7	115	556	7,944
18	ATAIE A	IRAN	7	19	2	15	7	19	108	1,055
19	AZIZ A	SAUDI ARABIA	7	56	3	6	3	53	11	97
20	CANALE A	ITALY	7	88	3	19	3	85	62	954
21	LI Y	PEOPLES R CHINA	7	34	5	27	6	24	69	2,418
22	LIDDLE JA	USA	7	109	5	66	7	109	432	44,623
23	SURESH U	ITALY	7	151	5	17	5	151	32	692
24	WANG Y	PEOPLES R CHINA	7	34	4	42	6	29	481	8,360
25	YANG P	PEOPLES R CHINA	7	30	3	19	5	27	183	1,175

V. ANALYSIS BY COUNTRY

Research is an important tool to determine the countries growth in terms of education. The main focus of this part is to analyze the Nano manufacturing research distribution across different countries. It doesn't matter if researchers moved from one country to another. So, an author may have publications from more than one country. USA and China received the highest number of authors because they have attracted a lot of researchers from all over the world due to good infrastructure for research.

The Table concluded that, USA is the most productive country in Nano manufacturing research. From the top 25countries list, USA has received more than 496 papers in Nano manufacturing with more than 11,419 citations. China comes in the second position with 374 articles with more than 5,020citations with lower H-index (35). Furthermore, it can be seen that some of the developing countries like Egypt and Saudi Arabia have also secured positions in the list of top 20 influential countries.

Table 6: The most influential countries in Nano manufacturing research.

Rank	Name	TP	TC	>100	>50	TP10	TC10	H
1	USA	496	11,419	13	36	337	5,394	50
2	PEOPLES R CHINA	374	5,020	5	14	281	3,396	35
3	INDIA	249	3,244	3	10	171	3,244	29
4	IRAN	155	1,470	2	3	140	1,326	20
5	SOUTH KOREA	131	3,257	3	8	1,841	95	29
6	JAPAN	82	1,596	1	7	44	1,596	23
7	GERMANY	63	1,598	3	7	38	1,598	21
8	ITALY	48	1,598	0	3	29	554	13
9	SAUDI ARABIA	36	354	0	2	19	323	10
10	TAIWAN	35	626	0	4	16	241	16
11	ENGLAND	33	1,016	4	3	24	297	14
12	FRANCE	31	414	0	1	31	414	12
13	SINGAPORE	31	816	1	5	13	693	14
14	AUSTRALIA	30	331	0	1	25	247	11
15	CANADA	27	296	0	0	22	296	11
16	EGYPT	23	279	0	1	19	279	9
17	SWITZERLAND	22	279	3	1	18	279	11
18	SPAIN	21	190	1	0	19	165	9
19	TURKEY	21	171	1	1	16	171	4
20	MALAYSIA	20	225	0	0	18	223	9
21	AUSTRIA	15	223	0	0	13	223	7
22	NETHERLANDS	13	184	0	1	11	168	6
23	RUSSIA	11	79	0	0	9	73	4
24	ROMANIA	10	168	0	0	8	71	6
25	SOUTH AFRICA	10	29	0	0	7	28	2

VI. CONCLUSIONS

This research has showed a bibliometric overview of Nano manufacturing research. The results shows that the Nano manufacturing research is receiving a progressive attention particularly specially in the last decade. Nano manufacturing has become one of the most influential topics due to its increasing application in manufacturing field. The bibliometric results show that, USA is the most influence country in electron beam melting field research followed by China in the second place and India in the third. BENELLI G is the highest author who has published in electron beam melting with 27 papers, next is WANG L (18 papers), MONTAZER M (15) papers in this field. USA has the highest number of the influential authors and also it received the highest number of publications and citations among all countries. China comes in the second position according to the number of publication in Nano manufacturing. Analyses of bibliometric shows that, many developing countries are becoming more influential, because of their significant researches in this area, and some of them including Egypt and Saudi Arabia are already obtaining remarkable results. This study presented a general bibliometric overview of Nano manufacturing research. The c web of science has been used as the source of bibliometric indicators and studies that have been reported in the journals not encompassed by WOS would have been neglected. However, the main objective of this study is that the reader can be informative about the Nano manufacturing research in terms of its impact and influence.

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