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INDIAN MATERIALS SCIENCE RESEARCH SCIENTOMETRICS

Kumari Reena

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University Department of library science, B.R.A. Bihar University, Muzaffarpur, India
E- mail: kumarireenapk@gmail.com

ABSTRACT

Another definition was provided by the Committee on Materials Science and Engineering of the National Research Council in its report titled "Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials." This definition included performance as the fourth component of the definition. According to this report, the study of materials for the purpose of controlling the four basic elements that make up materials—properties, structure and composition, synthesis and processing, and performance—and understanding the strong interrelationships among them is what constitutes materials science. Because materials played such a crucial role in the progression of civilization, humans have maintained a close relationship with them over the millennia. During the Stone Age, which is considered to be the beginning of human life on Earth, humans exclusively used natural materials such as stone, clay, skins, and wood. Around 3000 BC, the Bronze Age began when humanity discovered copper and learned how to make it harder by alloying it with other metals.

KEYWORDS: Indian, Materials, Civilization

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

INTRODUCTION

There are many different ways that materials science might be characterized in the literature. Materials science has been defined as a multidisciplinary field concerned with the fundamental nature of materials and their applications, with the generation and application of knowledge relating to the composition, structure, and processing of materials to their properties and uses, as stated in the summary report of the Committee on the Survey of Materials Science and Engineering (COSMAT) of the United States National Academy of Sciences, which was published in 1974. This definition acknowledges three fundamental aspects of the field of material science: the structure, the composition, and the processing and qualities of the material. Another definition was provided by the Committee on Materials Science and Engineering of the National Research Council in its report titled "Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials." This definition included performance as the fourth component of the definition. According to this report, the study of materials for the purpose of controlling the four basic elements that make up materials—properties, structure and composition, synthesis and processing, and performance—and understanding the strong interrelationships among them is what constitutes materials science.

The term "new and advanced materials" is almost synonymous with the field of materials science. This new field of study has resulted in the development of various novel materials with the goals of reducing weight, maximising the use of energy, lowering costs, and improving efficiency. Their uses in computers, autos, communication equipment, structural items, etc. have significantly improved the quality of life in many ways; modern appliances are lighter and more efficient, while automobiles and aeroplanes use less fuel while travelling at higher speeds. By exerting control over the structure of the material even at nano, micro, and macroscales, materials science is now able to create more sophisticated materials. These types of materials are able to fulfil the high-performance requirements set by the majority of today's technology, which include supersonic aeroplanes and space vehicles, amongst others. Industries such as aircraft, autos, biomaterials, chemicals, electronics, energy, and communications are still seeking for new, better, and more cost-effective materials and methods to satisfy their essential requirements.

AN OVERVIEW OF MATERIALS SCIENCE RESEARCH IN INDIA

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

Because materials played such a crucial role in the progression of civilization, humans have maintained a close relationship with them over the millennia. During the Stone Age, which is considered to be the beginning of human life on Earth, humans exclusively used natural materials such as stone, clay, skins, and wood. Around 3000 BC, the Bronze Age began when humanity discovered copper and learned how to make it harder by alloying it with other metals. Around 1200 BC, people began using iron and steel, which were far more durable materials that provided them an advantage in battle. The invention of a low-cost method of producing steel around the year 1850 was the subsequent significant step, as it paved the way for the construction of railways and the contemporary infrastructure of the industrial world. 7 The study of materials is an interdisciplinary topic that examines the characteristics of matter in addition to the ways in which these properties may be applied in other branches of science and engineering. The link between the structure of materials on atomic or molecular sizes and their macroscopic characteristics is the focus of this branch of science, which explores the interaction between the two. It includes aspects of both theoretical and practical chemistry and physics. As a result of its emphasis on nanoscience and nanotechnology, materials science has emerged as one of the most important subfields of study in recent years. Materials that are used in high-tech applications, which are typically designed for the maximum performance and are normally expensive. Some examples of these materials include magnetic alloys for computer discs, titanium alloys for supersonic aeroplanes, special ceramics for the heat shield of the space shuttle, and so on. Research in the field of materials science is being carried out in a significant capacity all over the world. Research in materials science is also being conducted at a significant number of universities and other academic institutions in India. The Indian Institute of Technology in Kharagpur, the Indian Institute of Science in Bengaluru, the Bhabha Atomic Research Centre in Mumbai, the Indira Gandhi Centre for Atomic Research in Kalpakkam, and the Indian Institute of Technology in Madras in Chennai are the most active institutes conducting the research in Materials Science in India. A separate chapter has been prepared on Materials Science, and it is discussed in detail in the fourth chapter.

RESEARCH METHODOLOGY

Since the dawn of human history, the materials have played an essential part in the progression of evolution. It's possible that the majority of us don't fully appreciate how deeply the materials are rooted in our society. Materials have an impact on every aspect of our lives, from the mundane to the profound. Throughout human history, the expansion and development of

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

civilizations have been closely linked to the ability of its members to cultivate and utilise natural materials in order to satisfy their fundamental need. In point of fact, anthropologists classify early civilizations according to the materials that were used and how they were used, such as the Stone Age, the Bronze Age, the Copper Age, and the Iron Age.

In the beginning of human history, people only employed a limited variety of natural materials, including as wood, clay, stone, epidermis, and so forth. In the course of time, people found new methods for shaping out and making materials that had qualities that were superior to those of the typical ones. Later on, people put into reality the idea that heat treatments might be used to transform materials by the addition of additional materials. The procedure entails the careful selection and blending of the components, as well as the use of the processes that are required to transform the raw materials into the finished products that satisfy the requirements.

GROWTH OF THE WORLD AND INDIAN SCIENTIFIC LITERATURE

The current state of scientific publications around the world and in India is presented in table 1The table also includes information on the distribution of publications in Materials Science of the World and India according to year. According to the findings of the survey, the field of Materials Science accounts for 5.61 percent of the total number of scientific papers produced throughout the world. The number of publications in India that are related to materials science make up 9.70 percent of the country's overall number of scientific publications. The total number of publications in the field of Materials Science throughout the globe is 12, 42,775, while India's total stands at 65,234 during the last fifteen years.

Table 1 Year wise Scientific Publications: World V/s India

Year	Scientific Publications (World)	rcentage (%)	Materials Science Publications (World)	Percentage (%)	Scientific Publications (India)	Percentage (%)	Materials Science Publications (India)	rcentage (%)
2002	1034960	4.67	51021	4.11	20716	3.08	1838	2.82
2003	1082219	4.88	53690	4.32	22912	3.41	2019	3.10
2004	1170092	5.28	61179	4.92	24920	3.71	2187	3.35

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

2005	1240004	5.60	62981	5.07	27747	4.13	2479	3.80
2006	1295368	5.84	67492	5.43	31146	4.63	2786	4.27
2007	1360669	6.14	71007	5.71	36375	5.41	3393	5.20
2008	1412111	6.37	75368	6.06	42616	6.34	3801	5.83
2009	1481516	6.68	78861	6.35	43964	6.54	4343	6.66
2010	1515982	6.84	80199	6.45	47286	7.03	4501	6.90
2011	1596237	7.20	88723	7.14	51547	7.65	4872	7.47
2012	1678782	7.57	92804	7.47	54730	8.14	5104	7.82
2013	1769840	7.99	103137	8.30	61170	9.10	6228	9.54
2014	1816832	8.20	112171	9.03	66326	9.87	6705	10.28
2015	1837430	8.29	119577	9.62	68551	10.20	7206	11.04
2016	1871884	8.45	124565	10.02	72352	10.76	7772	11.91
	2,21,63,926	**100**	**12,42,775**	**100**	**6,72,358**	**100**	**65,234**	**100**
	Percentage Share of Materials Science Publication (World)	5.61			Percentage Share of Materials Science Publications(India)	9.70		

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

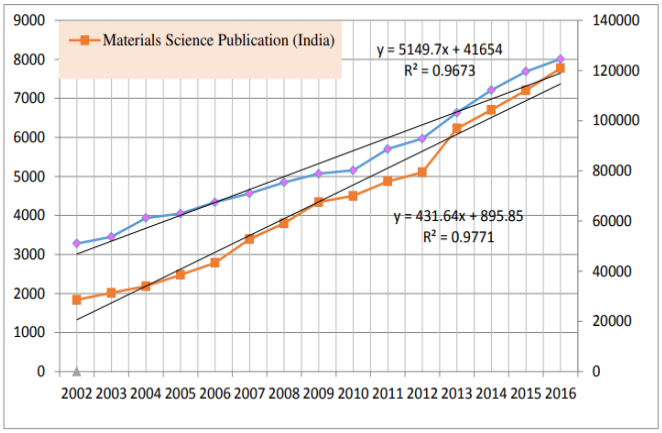

Figure 1 Publications' Trends in Materials Science: World Vs India

The percentage of total contribution made by India to the field of Materials Science from 2002 to 2016 is 5.25%. When compared to the rest of the globe, India's rate of publishing growth (R2 = 0.977) is much higher than the global average (R2 = 0.967). In addition, the publishing trend for the field of Materials Science is presented in Figure1.

Table 2 Year wise Materials Science Publications of the World(RGR & Dt.)

Years	Materials Science Publications	Cumulative No. of Publications	w1	w2	RGR (w2-w1)	Dt.
2002	51021	51021		10.84		
2003	53690	104711	10.84	11.56	0.72	0.96
2004	61179	165890	11.56	12.02	0.46	1.51
2005	62981	228871	12.02	12.34	0.32	2.15
2006	67492	296363	12.34	12.60	0.26	2.68
2007	71007	367370	12.60	12.82	0.21	3.23
2008	75368	442738	12.82	13.00	0.19	3.71
2009	78861	521599	13.00	13.17	0.16	4.23

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

2010	80199	601798	13.17	13.31	0.14	4.84
2011	88723	690521	13.31	13.45	0.14	5.04
2012	92804	783325	13.45	13.57	0.13	5.50
2013	103137	886462	13.57	13.70	0.12	5.60
2014	112171	998633	13.70	13.82	0.12	5.82
2015	119577	1118210	13.82	13.93	0.11	6.13
2016	124565	1242775	13.93	14.03	0.11	6.56
	1242775				**3.19**	**57.95**
				Mean	**0.21**	**3.86**

*RGR=Relative Growth Rate , Dt=Doubling Time

The Relative Growth Rate (RGR) is the increase in the number of articles per unit of time. The RGR and Doubling time of publications in Materials Science are presented in table 2.

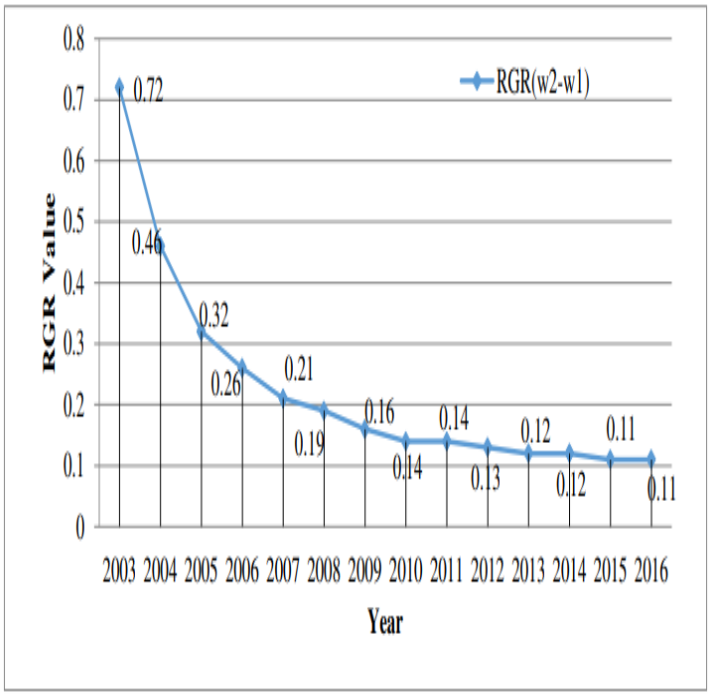

Figure 2 Relative Growth Rate

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

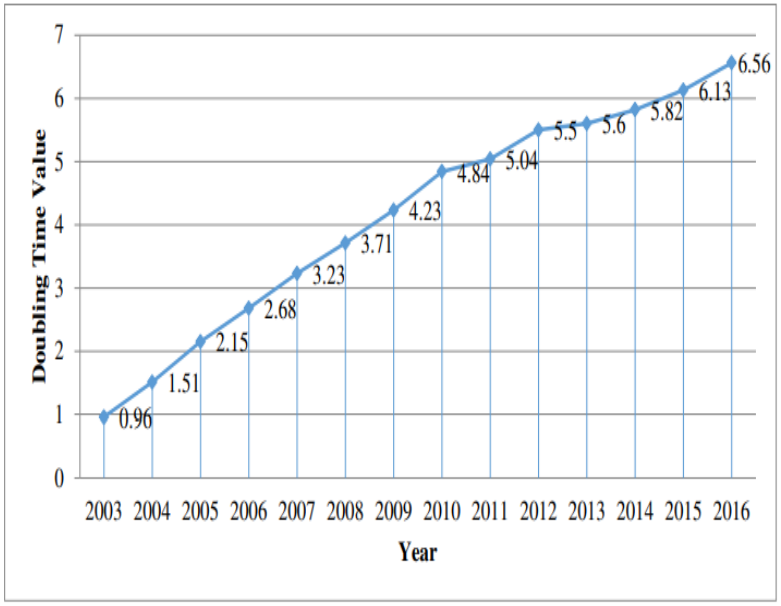

Figure 3 Doubling Time

It is noticed that the RGR of Publications decreased from 0.72 in 2003 to 0.11 in 2016. The mean RGR for fifteen years' period is 0.21. Thecorresponding Doubling time for different years gradually increased from 0.96 (2003) to 6.56 (2016). The mean Doubling time for the selected period (2002 to 2016) is 3.86.

Table 3 Research output of top fifteen countries in the field of Materials Science

Year	China	USA	Japan	Germany	South Korea	India	France	England	Italy	Taiwan	Spain	Canada	Russia	Australia	Iran
2002	5389	9199	7191	4425	2452	1838	3428	2849	1560	1097	1487	1171	1945	827	119
2003	6680	9758	7390	4163	2714	2019	3205	2860	1605	1302	1343	1278	1880	840	189
2004	7762	10976	7786	4834	3603	2187	3589	3101	1960	1545	1643	1503	2103	991	240
200	10127	11219	7254	4678	3854	2479	3449	2924	1648	1597	1554	1721	1800	1026	271

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

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2006	11161	11888	7529	4626	4341	2786	3657	3040	1668	2289	1753	1903	1868	1158	442
2007	12848	13032	7363	5116	3774	3393	3784	3132	1970	2059	1909	1931	1806	1195	579
2008	15003	13183	6705	4934	4312	3801	4219	3180	2065	2298	1954	1998	1795	1390	835
2009	16841	13891	6745	5209	4845	4343	4120	3367	2097	2574	2095	2153	1774	1519	1338
2010	17246	14861	6083	5409	5238	4501	4010	3307	2292	2614	2197	2191	1611	1746	1613
2011	20556	15939	6517	6232	6308	4872	4402	3465	2559	2929	2437	2318	1853	1913	1900
2012	23290	16410	6067	6006	6571	5104	4402	3569	2502	2741	2685	2364	1873	2166	2156
2013	27751	17339	6554	6501	7316	6228	4859	3869	2969	3130	2826	2545	2042	2482	2543
2014	33418	18882	6565	6995	7902	6705	4768	4070	3098	3037	3126	2772	2349	2844	2811
2015	38406	20064	6298	7391	8203	7206	5097	4612	3243	2732	3189	2944	2972	3124	3094
2016	41258	20781	6649	7557	8645	7772	5143	4985	3506	2630	3361	2995	3051	3327	3632
Total	**2,87,736**	**2,17,422**	**1,02,696**	**84,076**	**80,078**	**65,234**	**62,132**	**52,330**	**34,742**	**34,574**	**33,559**	**31,787**	**30,722**	**26,548**	**21,762**

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

AVG	19182	14495	6846	5605	5339	4349	4142	3489	2316	2305	2237	2119	2048	1770	1451

*AVG= Average publication per paper

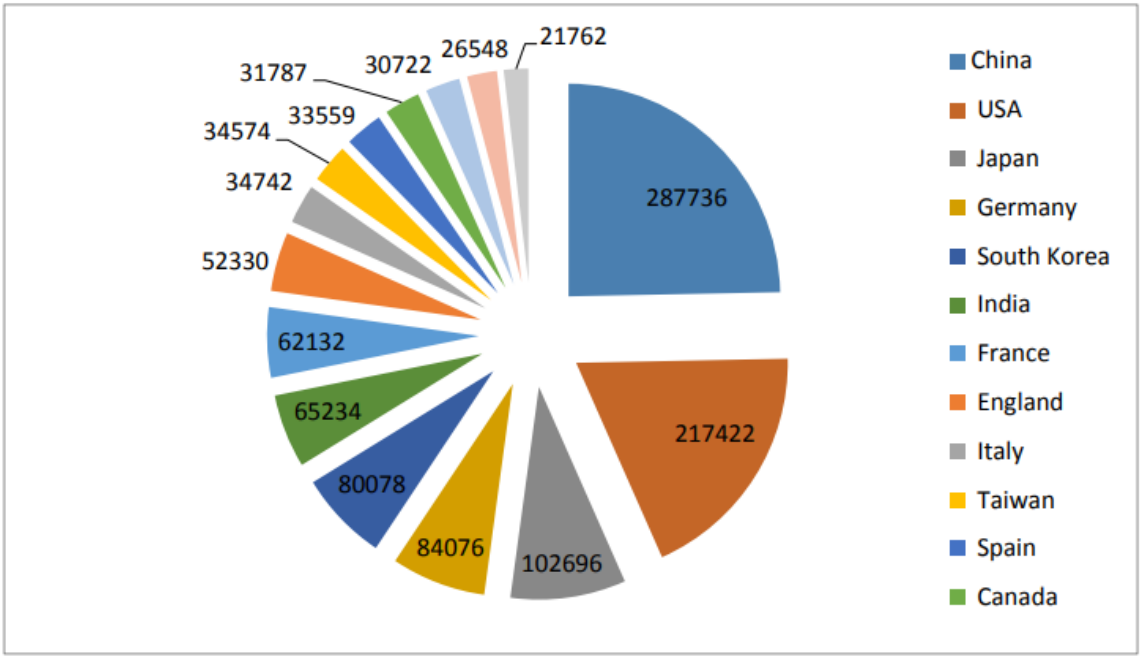

Figure 4 Research output of top fifteen countries in the field of MaterialsScience

The research output of the top fifteen nations in Materials Science is listed in table 4.3. According to the findings of the survey, China came in first place with a total of 2,87,736 publications, followed by the United States of America with 2,17,422 publications, Japan with 1,02,696 publications, Germany with 84,076 publications, and South Korea with 80,078 publications in that order. With a total of 65,234 publications, India took the sixth spot on the rankings. Eight of the top fifteen highly productive nations are developed countries, while the other seven are developing countries. Developing countries make up seven of the top fifteen highly productive countries. There has been a significant amount of work done in the field of materials science by researchers from poor nations. China has the most number of publications on a yearly basis (19,182), whereas Iran has the fewest publications on a yearly basis (145 publications). Because of this, the theory 1: China, India and South Korea are the Major Contributors in Materials Science from Asia is accepted.

Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

CONCLUSION

The study draws attention to the most significant challenges facing the advancement of materials science research in India, as represented in the Web of Science database. Research into materials science in India is now ranked as the fourth most important area in terms of the number of publications produced by the country's overall scientific community. Research & Development Centers and Institutions of National Importance have made significant contributions to the area of Materials Science, both in terms of the number of publications that they have produced and the number of citations that have been made to those articles. The investigator has utilised h-Index and its associated h-metrics in order to evaluate the overall performance of Indian scholars in terms of their publication output. There is a large gap in quality amongst the top fifteen authors, as seen above.

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Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com

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Kumari Reena *, *Department of library science, B.R.A. Bihar University, Muzaffarpur, India.*
E-mail: kumarireenapk@gmail.com