

## Research Contribution of Prof Atul H. Chokshi to Materials Science: A Scientometric Study

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### ABSTRACT

An eminent scientist, Dr Atul H. Chokshi, Professor in the Department of Materials Science, Indian Institute of Science (IISc), Bangalore, India has published 76 research papers in reputed international journals, and 34 articles in conference proceedings. These publications have received 2820 citations, and he is listed among the top 100 most cited authors in Materials Science. His research domains include Superplastics, Creep, Deformation, and Grain growth. Average annual scientific productivity is four research papers and his research papers have received an average of 113 citations every year. Average number of citations per paper is 26. The 50-percentile productivity life is 13 at the age of 39 years, and productivity co-efficient is 0.50. Average self-citation rate is 11.5 % of the total citations. Seven most-cited papers account for 44.54 % of total citations received, and these papers have received citations within a year of their publication. Average number of authors per paper is 2.2 and collaboration co-efficient is 0.88, indicating high degree of collaboration. He has collaborated extensively with T.G. Langdon, A.K. Mukherjee, D.M. Owen, M.A. Meyers, and J.R. Peters to publish 44 research papers and these papers have received 1680 citations (59.5 % of total citations). UK and USA were the most preferred countries for research collaboration. *Journal of American Ceramic Society* and *Scripta Materialia* were the most-preferred journals to publish research findings. A single article published in *Materials Science and Engineering R-Reports*, with an impact factor of 04.79 has been cited 207 times, which is the highest number of citations any of his research papers have received. With these achievements, Atul H. Chokshi is a role model for emulation among younger generation of scientists.

**Keywords:** Atul H. Chokshi, materials science, scientometric study, biobibliometric study

### 1. INTRODUCTION

Scientists, as creators of information, play a significant role in the advancement of Science. Scientific publications provide the best available basis for measuring the research output of a scientist, an institution or a nation. Shockley<sup>1</sup> first used the publications for measuring the research productivity among individuals within a group by analysing their publications. Lotka<sup>2</sup> stated in his 'Inverse square law of scientific productivity' that highly productive authors form a very small proportion of the total in any given field of research. On the other hand, impact of publications of a scientist is measured in terms of number of citations received by these publications. A publication that is never read can have little impact. Hence, study of the scientific productivity and impact of eminent scientists can throw light on the pattern of scholarly communication in

a given discipline, and can also stimulate younger generation to emulate them. An attempt is made to present the results of analysis related to the scientific productivity, authorship, and collaborative authorship pattern, countries and scientists preferred to collaborate, and impact of research of Atul H. Chokshi, Professor of Materials Science, IISc, Bangalore, India.

### 2. ABOUT PROF ATUL H. CHOKSHI

Atul H. Chokshi was born on 24 March 1958. He received BTech degree in Metallurgy from Indian Institute of Technology, Chennai in 1980. He completed MS and PhD degrees from the University of Southern California, USA. Prior to joining IISc, Bangalore, in 1994 as a Professor, he was part of the faculty of University of California, San Diego, USA for five years. Also, he held visiting faculty position in more than six universities in USA,

Europe, and Japan. Dr Chokshi is one of the pioneers in the new branch of Materials Science, namely, mechanical behavior of nanomaterials. He has made significant contribution in the areas of Superplasticity and understanding of deformation mechanisms that bring about this phenomenon. He has made in-depth studies on the effect of temperature, grain size and microstructure on the superplastic deformation, creep, diffusion in ceramics, ceramic composites, and magnesium alloys.

He has published 110 research papers in international journals and conference proceedings and these publications have received 2820 citations, as on 30 September 2010. He has also published four books. Eight researchers were awarded doctoral degree under his research guidance. He is ranked among the top 100 most-cited Materials Scientists in the world<sup>3</sup>.

Dr Chokshi has received many honours and awards. He is a fellow of the Indian Academy of Sciences, Indian National Academy of Engineering, Indian National Science Academy, and National Academy of Sciences, India. He is recipient of JD Birla Award (2006), *Metallurgist of the Year Award* (2001) from Indian Institute of Metals, *SS Bhatnagar Award* (2003), *MRSI Medal* (2000), and *Swarna Jayanti Presidential Young Scientist Award* (1998)<sup>4</sup>.

### 3. LITERATURE REVIEW

Individuals are the basic foundation of any institution. A study of scientific productivity and impact of research of individuals with significant scientific achievements can help in understanding the dynamics of scholarly communication and may stimulate the younger generation to emulate them.

Tiew<sup>5</sup> presented an analysis of the publication productivity, authorship pattern, channels of communication, journal preference and language preference of Khoo Kay Kim, Professor of Malaysian History in the University of Malaysia, Kaula Lumpur. A bio-bibliometric study by Koley & Sen<sup>6</sup>, in their study finds that the data do not follow Bradford's distribution. Citation analysis of H.J. Bhabha has been undertaken by Swarna<sup>7</sup>, *et al.* and Kademani<sup>8</sup>, Bio-bibliometric study by Parvathamma<sup>9</sup>, *et al.* highlights the achievements of T.A. Aminabhvi, which includes publication of 151 research papers with collaborative co-efficient of 0.9, important collaborators, and collaborating countries.

Academic and research achievements of several Nobel Laureates and Eminent Scholars have been undertaken so far including Prof S.R. Ranganathan<sup>10</sup> Y.M. Kochen<sup>11</sup>, Vinodini Reddy<sup>12</sup>, I.N. Sengupta<sup>13</sup>, M.S. Swaminathan<sup>14</sup>, P.K. Iyengar<sup>15</sup>, C.V. Raman<sup>16</sup>, S. Chandrasekhar<sup>17</sup>, Pierre-Gilles de Gennes<sup>18</sup>, Barbara Mc Clintock<sup>19</sup>, Ahmed Hassan Zewail<sup>20</sup>, Vikram Ambalal Sarabhai<sup>21</sup>, Ranjit Kumar Mitra<sup>22</sup>, R.C. Sinha<sup>23</sup>,

Harold W. Kroto<sup>24</sup>, Ram Gopal Rastogi<sup>25</sup>, Leland H. Hartwell<sup>26</sup>, Anthony J. Leggett<sup>27</sup>, N. Rudraiah<sup>28</sup>, S. Ramaseshan<sup>29</sup>, Nayana Nanda Borthakur<sup>30</sup>, Harald Zur Hausen<sup>31</sup>, and Atta-Ur-Rahaman<sup>32</sup>.

### 4. OBJECTIVES

The objectives of the study are to find out the channels preferred to publish research findings; chronology of research publications, and citations received; scientific productivity of Atul H. Chokshi in various domains; most cited papers of Atul H. Chokshi; authorship pattern; collaborative authorship pattern; researchers collaborating with Atul H. Chokshi; countries preferred for collaboration; and journals preferred for publishing the findings.

### 5. METHODOLOGY

Bibliographic details of the research publications and the citation data were downloaded from *Web of Science* database for the period, 1985-2010<sup>33</sup>. The data was transferred to MS-Excel worksheets and analysed to meet the above mentioned objectives. Only citations to research articles published in journals, and conference proceedings were considered for analysis.

### 6. RESULTS AND DISCUSSIONS

#### 6.1 Publication Channels Used

Scientific periodicals (69.09 %), and Conference proceedings (30.91 %) are the two forms of literature preferred by Atul H. Chokshi to publish his research findings (Table 1). Also, journal articles have received maximum citations (85 %) compared to papers in conference proceedings.

**Table 1. Types of documents preferred for publishing research findings**

Type of document	No. of publications (%)	No. of citations received (%)
Journal articles	76 (69.09 %)	2397 (85 %)
Papers in conference proceedings	34 (30.91 %)	423 (15 %)
<b>Total</b>	<b>110 (100 %)</b>	<b>2820 (100 %)</b>

#### 6.2 Domain-wise Distribution

Domain(s) within Materials Science were identified with the help of keywords in the title of each publication. Atul H. Chokshi has contributed 51 papers in 'Superplastics', followed by 40 papers in the domain of 'Creep', and 32, and 30 papers in the domains of 'Deformation' and 'Grain growth' respectively (Table 2).

#### 6.3 Chronology of Research Publications

Atul H. Chokshi has published an average of 4.4 papers per year during 1985-2010, with exception

**Table 2. Domainwise distribution of research papers**

Domain name	No. of publications (%)
Superplastics	51 (17.22 %)
Creep	40 (13.50 %)
Deformation	32 (10.81 %)
Grain growth	30 (10.13 %)
Alumina	29 (9.80 %)
Zirconia	27 (9.12 %)
Nanocrystals	20 (6.74 %)
Cavity growth	19 (6.41 %)
Alloy, mechanical properties	16 (5.40 %)
Diffusion	14 (4.80 %)
Ceramic composites	10 (3.37 %)
Polycrystalline	8 (2.70 %)
<b>Total</b>	<b>296 (100 %)</b>

of the years 2002, and 2004 with nil publications. Average number of citations received per year is 112.8. Average number of citations per publication

is 26. 50-percentile productivity life is the productive age at which half of the research publications were published. Productivity co-efficient is the ratio of productive life (corresponding to 50-percentile productivity)/total productive life<sup>26</sup>. The 50-percentile productivity life of Atul H. Chokshi was 13 at 39 years of age. Hence, the productivity co-efficient amounts to 0.50.

#### 6.4 Self-Citations

Self-citation means the author citing his own work. Self-citations are the significant means of promoting scholarly reputation and gaining professional credit for one's research. They also indicate the continuity of one's own research. Self-citations account for 10-20 % of all references, but it differs between disciplines, from 15 % in physical sciences to 6 % in sciences<sup>34,35</sup>. Among 2820 citations received by the research papers of Atul H. Chokshi, 325 are self-citations (11.52 %) (Fig. 1).

**Table 3. Chronology of research papers and citations**

Year	No. of publications	No. of citations these publications have received	Cumulative no. of publications	Cumulative no. of citations	Average no. of citations per publication	Productive age	Biological age
1985	3	87	3	87	29	1	27
1986	5	121	8	208	24	2	28
1987	8	214	16	422	27	3	29
1988	4	116	20	538	29	4	30
1989	4	563	24	1101	141	5	31
1990	5	127	29	1228	25.4	6	32
1991	5	275	34	1503	55	7	33
1992	1	139	35	1642	139	8	34
1993	5	233	40	1875	47	9	35
1994	6	160	46	2035	27	10	36
1995	2	100	48	2135	50	11	37
1996	3	75	51	2210	25	12	38
1997	6	128	57	2338	21	13	39
1998	3	71	60	2409	24	14	40
1999	4	90	64	2499	23	15	41
2000	4	98	68	2597	25	16	42
2001	9	76	77	2673	8	17	43
2002	0	0	77	2673	0	18	44
2003	7	40	84	2713	6	19	45
2004	0	0	84	2713	0	20	46
2005	8	70	92	2783	9	21	47
2006	1	9	93	2792	9	22	48
2007	2	9	95	2801	5	23	49
2008	6	12	101	2813	2	24	50
2009	5	7	106	2820	1	25	51
2010	4	0	110	2820	0	26	52
<b>Total</b>	<b>110</b>	<b>2820</b>		<b>Average</b>	<b>26</b>		

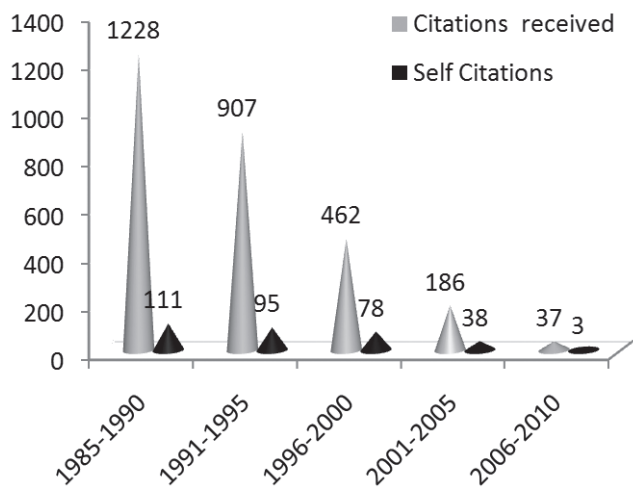


Figure 1. Citations vs self-citations.

### 6.5 Most Cited Research Papers

Table 4 shows that seven research papers have received 1256 citations (44.54 %) and have started receiving citations within a year of their publication and continue to receive citations till date. Hence, these research papers are considered to have influenced the field of Materials Science to a greater extent. Among remaining 103 articles

(55.46 %), 20 articles have not received any citation till date.

### 6.6 Authorship Pattern

Atul H. Chokshi has authored 29 research papers (26.36 %) independently and remaining 81 papers (73.64 %) in collaboration with 219 authors. Two-authored papers constitute 35.48 % of the total research papers. Average number of authors per paper is 2.25 and average number of citations per paper is 26. Collaboration co-efficient is calculated using the formula proposed by Subramanyam<sup>36</sup> and it is found to be 0.88, indicating high degree of collaboration (Table 5).

Table 5. Authorship pattern

No. of authors per paper	No. of papers (%)	Total no. of authors (%)	No. of citations received (%)
1-Author	29 (26.36 %)	29 (11.69 %)	406 (14.40 %)
2-Authors	44 (40 %)	88 (35.48 %)	828 (29.36 %)
3-Authors	17 (15.45 %)	51 (20.56 %)	705 (25 %)
4-Authors and above	20 (18.18 %)	80 (32.26 %)	881 (31.24 %)
<b>Total</b>	<b>110 (99.99 %)</b>	<b>248 (99.99 %)</b>	<b>2820 (100 %)</b>
<b>Average no. of citations per paper</b>			<b>26</b>

Table 4. Most cited research papers of Atul H. Chokshi

Authors	Title of the article	Journal/ conference (Place of publication)	Year of publication	No. of citations received	First-last year of citation
Chokshi, A.H., Rosen A. et al.	On validity of the Hall peth relationship in Nanocrystalline materials	<i>Scripta Metallurgica</i> (United Kingdom)	1989	485	1990-2009
Chokshi, A.H., Mukherjee A.K., et al.	Superplasticity in advanced materials	<i>Materials Science and Engineering R-Reports</i> (Netherlands)	1990	207	1991-2009
Chokshi, A.H.	Superplasticity in fine grained Ceramics and Ceramic Composites	Workshop on Grain Boundary. 12-16 Oct 1992 (Oakland, California, USA)	1992	139	1994-2010
Andrade, U.; Meyers, M.A.; Chokshi, A.H.; et al.	Dynamic recrystallisation in high strain, Plastic deformation	<i>Acta Metallurgica et Materialia</i> (Netherlands)	1994	115	1995-2010
Owen, D. M. & Chokshi, A.H.	The high temperature mechanical character of Superplastics....	<i>Acta Materialia</i> (United Kingdom)	1998	108	1998-2010
Owen, D.M., Chokshi, A.H. & Nutt, S.R.	The high temperature ....	<i>Journal of American Ceramic Society</i> (USA)	1997	101	1998-2009
Schissler, D.J.; Chokshi, A.H. & Neih, T.G.	Microstructural aspects of Superplastic tensile...	<i>Acta Metallurgica et Materialia</i> (Netherlands)	1991	101	1991-2009
<b>No. of citations received by these 07 articles</b>				<b>1256 (44.54 %)</b>	
<b>No. of citations received by 20 articles</b>				<b>0</b>	
<b>No. of citations received by remaining 83 articles</b>				<b>1564 (55.46 %)</b>	
<b>Total number of citations</b>				<b>2820 (100 %)</b>	

## 6.6 Collaborative Authorship

Among 219 collaborating authors, Atul H. Chokshi has published 64 papers (58.18 %) with 10 scientists during 1986-2010 (1802 citations) (Table 6). He has published 9 research papers with T.G. Langdon and these papers have received highest number of citations (524). His collaboration with A.K. Mukherjee,

D.M. Owen, J.R. Potter, and M.A. Meyers has also led to the publication of highly cited papers. His association with Dr M.N.J.V. Prasad is the shortest since 2006.

## 6.7 International Collaboration

Atul H. Chokshi has collaborated extensively with scientists from UK, USA, Netherlands, China,

**Table 6. Authors collaborating with Atul H. Chokshi**

S. No.	Author name	No. of papers published	No. of citations these publications have received	Cumulative no. of publications	Cumulative no. of Citations received	First-last publication year (Years of association)
1.	Langdon, TG	9	524	9	524	1987-1996 (10 years)
2.	Kottada, RS	8	54	17	578	1998-2007 (10 years)
3.	Mukherjee, AK	8	302	25	880	1986-1993 (08 years)
4.	Owen, DM	8	280	33	1160	1990-2000 (11 years)
5.	Porter, JR	6	254	39	1414	1986-1997 (12 years)
6.	Jayaram, V	6	38	45	1452	1997-2007 (11 years)
7.	Meyers, MA	5	266	50	1718	1990-1995 (06 years)
8.	Gandhi, AS	5	35	55	1753	1997-2005 (09 years)
9.	Nieh, TG	5	35	60	1788	1997-2005 (09 years)
10.	Prasad, MNJV	4	14	64	1802	2006-2010 (05 years)
11.	Remaining 209 authors	46	1018	110	2820	

**Table 7. International collaboration**

Collaborating country	No. of papers published (%)	Cumulative papers published (%)	No. of citations received (%)	Cumulative citations (%)
UK	28 (25.45 %)	28 (25.45 %)	1006 (35.67 %)	1006 (35.67 %)
USA	25 (22.73 %)	53 (48.18 %)	549 (19.47 %)	1555 (55.14%)
Netherlands	8 (7.27 %)	61 (55.45 %)	498 (17.66 %)	2053 (72.80 %)
China	6 (5.45 %)	67 (60.91 %)	239 (8.48 %)	2292 (81.28 %)
Germany	6 (5.45 %)	73 (66.36 %)	220 (7.80 %)	2512 (89.08 %)
Other countries	37 (33.64 %)	110 (100 %)	308 (10.92 %)	2820 (100 %)

**Table 8. Journals preferred to publish research findings**

S. No.	Name of journal	Country of publication	Impact factor (2011)	No. of articles published	No of citations received	Average citations per article
1.	<i>Journal of the American Ceramic Society</i>	USA	2.272	14	297	21.22
2.	<i>Scripta Materialia</i>	UK	2.699	10	131	13.1
3.	<i>Acta Materialia</i>	UK	3.755	8	248	31
4.	<i>Scripta Metallurgica</i>	UK	0.912	5	505	101
5.	<i>Scripta Metallurgica et Materialia</i>	UK	0.898	5	122	24.4
6.	<i>Materials Science and Technology</i>	China	0.982	4	99	24.8
7.	<i>Acta Metallurgica et Materialia (formerly Acta Metallurgica)</i>	Netherlands	2.030	5	394	78.8
8.	<i>Materials Science and Engineering A – Structural Materials Properties, Microstructure &amp; Processing</i>	Netherlands	0.986	4	25	6.3
9.	<i>Metallurgical and Materials Transactions A-Physical Metallurgy &amp; Materials Science</i>	USA	1.460	6	172	28.7
10.	<i>American Ceramic Society Bulletin</i>	USA	0.389	2	77	38.5
11.	<i>Journal of Materials Science</i>	Netherlands	0.741	2	85	42.5

Cont....

**Table 8. Journals preferred to publish research findings**

S. No.	Name of journal	Country of publication	Impact factor (2011)	No. of articles published	No of citations received	Average citations per article
12.	<i>Journal of Materials Science Letters</i>	Germany	0.441	3	20	06.7
13.	<i>Transactions of the Indian Institute of Metals</i>	India	0.205	2	00	0
14.	<i>Journal of Materials Research</i>	USA	2.000	2	03	1.5
15.	<i>Journal of Metals</i>	USA	0.862	1	00	0
16.	<i>Materials Letters</i>	Netherlands	2.307	1	12	12
17.	<i>Materials Science &amp; Engineering R – Reports</i>	Netherlands	4.792	1	207	207
18.	<i>Current Science</i>	India	0.935	1	0	0
<b>Total No. of articles published &amp; citations to journal articles</b>				<b>76</b>	<b>2397</b>	<b>31.5</b>
<b>Total No. of articles published &amp; citations to Conf. papers</b>				<b>34</b>	<b>423</b>	<b>12.4</b>

and Germany. He has published 53 research papers with scientists from UK and USA (48.18 %). These papers account for 1555 citations (55.14 %) (Table 7).

### 6.8 Journals Preferred for Publishing Research Findings

Atul H. Chokshi has published 76 research articles in 18 journals from USA (5), UK (4), Netherlands (5), Germany (1), China (1) and India (2). A single article published in *Materials Science and Engineering R-Reports*, published from Netherlands, which has highest impact factor of 4.792 has attracted highest number of 207 citations. Average number of citations received by each journal is 31.5. Forty seven research papers are published in journals with impact factor of 1.00 or more. Articles published in *Transactions of Indian Institute of Metals* (02) and *Current Science* (01) has not received any citations during the study period (Table 8).

## 7. CONCLUSIONS

Atul H. Chokshi is one of the productive authors in Materials Science and influence of his publications is evident from the number of citations received. Scientometric study of his research publications and citations received has led to better understanding of the intricacies of scholarly communication in the field of Materials Science. Also, it would serve as an inspiration to the younger generation of Material Scientists to emulate him as their role model.

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