



DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Top Global Researchers and Organizations in Low Observable Material Science

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ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense information analysis center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

DSIAC serves as the national clearinghouse for worldwide scientific and technical information for weapon systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. We collect, analyze, synthesize, and disseminate related technical information and data for each of these focus areas.

A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit www.DSIAC.org.

ABSTRACT

DSIAC was asked to search available databases to identify the top global researchers and organizations in low observable (LO) material science. DSIAC searched multiple literature databases, including Elsevier's Scopus database and Clarivate's Derwent Innovations and Web of Science (WoS) databases, to provide information on the publications, number of citations, and patents awarded in LO material science technology and research development. Lists of the top global researchers and affiliations were compiled based on patents awarded and Scopus and WoS database publications and citations.

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1.0 TI Request

1.1 INQUIRY

Who are the leading global researchers and organizations in low observable (LO) material science?

1.2 DESCRIPTION

The inquirer asked the Defense Systems Information Analysis Center (DSIAC) to search available resources to identify the top global researchers and organizations in LO material science.

2.0 TI Response

DSIAC completed literature searches for publications and patent information on LO material science technology via the Scopus database and Clarivate’s Derwent Innovation and Web of Science (WoS) databases. DSIAC used a combination of the following search terms:

- stealth AND military AND (material OR coating)
- “low observable” AND (infrared OR coating)
- “low observable” AND (materials OR design OR shaping)
- stealth AND (materials OR design OR infrared)

The searches were limited to the past 3 years so that the results would reflect the most recent research. The results across all searches are compiled in Table 1.

Table 1: Top Researchers Across All Searches

Researcher	No. of Patents Granted	No. of Patents Pending	No. of Scopus Publications	No. of WoS Publications
Cheng, Hai-feng	13	—	—	—
Liu, Hai-tao	12	—	—	—
Pottier, Agnes	10	—	—	—
Levy, Laurent	10	—	—	—
Meyre, Marie-Edith	10	—	—	—
Cao, Tun	10	31	—	—
Zhou, Yong-jiang	10	—	—	—
Cui, Hua-gang	9	—	—	—
Yao, Jun-feng	8	—	—	—
Zhang, Chao-yang	8	—	—	—

Table 1: Top Researchers Across All Searches (Continued)

Researcher	No. of Patents Granted	No. of Patents Pending	No. of Scopus Publications	No. of WoS Publications
Qu, Shaobo	—	—	11	12
Wang, Jia-fu	—	—	9	11
Pang, Yongqiang	—	—	8	10
Zhang, Anxue	—	—	8	—
Baskey, Himangshu Bhusan	—	—	7	—
Brookner, Eli	—	—	7	—
Chen, Juan	—	—	7	—
Jiang, Tian	—	—	7	—
Singh, Dharmendar Kumar	—	—	7	10
Liu, Ruihuang	—	—	7	—
Panwar, Ravi	—	—	7	—
Xu, Guoyue	—	—	7	—
Zhang, Jieqiu	—	—	7	—
Zhao, Dapeng	—	—	7	—
Huang, Jun	—	—	7	—
Li, Xiong	—	—	—	12
Li, Guanyong	—	—	—	10
Zhang, Yin	—	—	—	9
Liu, Yujia	—	—	—	9
Wang, Jian-wei	—	—	—	9
Zhang, Jing	—	—	—	9
Zhou, Jian-jing	—	17	—	—
Yamashita, Shigeyuki	—	17	—	—
Junkers, Eric P.	—	15	—	—
Junkers, John K.	—	14	—	—
Wang, Fei	—	14	—	—
Shi, Chen-guang	—	13	—	—
Zhang, Xiaoxing	—	12	—	—
Li, Hai-lin	—	12	—	—
Wang, Feng	—	12	—	—

Note: WoS = Web of Science.

The following results are provided in Sections 2.1 and 2.2:

- Top researchers and organizations based on the number of patents awarded and pending in LO material science research (Section 2.1).
- Research and patent trends among top countries performing LO material science research (Section 2.1).
- Top researchers and organizations based on the number of publications and citations found in Scopus (Section 2.2).
- Top researchers and organizations found in the WoS database (Section 2.2).

2.1 TOP RESEARCHERS/ORGANIZATIONS BASED ON PATENTS

The Derwent Innovation database, part of Clarivate Analytics, was used to search for global researchers in LO material science based on the number of granted (awarded) patents.

Searches were performed using the following terms:

- stealth AND military AND (material OR coating)
- “low observable” AND (infrared OR coating)
- “low observable” AND (materials OR design OR shaping)
- stealth AND (materials OR design OR infrared)

A spreadsheet containing patent information for the top results found in Derwent Innovations was exported and delivered to the inquirer for further review.

2.1.1 Patents Granted

The search parameters included patents granted in 2016 to the present and alive and indeterminate patents. The total number of hits was 733, and 100 (i.e., 14%) of the patents are from the top organizations (shown in Table 2).

Table 2 lists the top organizations based on patents granted, with the top researcher from the associated organization. The researchers identified in bold in Table 2 can also be found in Table 3, which lists the top researchers, based on patents granted, in descending order. The top researchers hold 100 patents, or 14% of the total patents granted.

Table 2: Top Organizations Based on Patents Granted

Organization	No. of Patents Granted per Organization	Top Researcher(s)	No. of Patents per Researcher
Dalian University of Technology	15	Cao, Tun	10
National University of Defense Technology, China	15	Cheng, Hai-feng	13
Nanjing University of Aeronautics and Astronautics	13	Zhou, Jian-jing	6
Nanobiotix	10	Pottier, Agnes	10
Harbin Institute of Technology	8	Li, Long-qiu	2
University of Electronic Science and Technology of China	8	Deng, Long-jiang	3
Massachusetts Institute of Technology	8	Wardle, Brian L.	3
Northwestern Polytechnical University, China	8	Zhang, Qun	4
Hnegyang Tellhow Communication Vehicles Co., Ltd.	8	Cui, Hua-gang	9
Shandong University	7	Liu, Jiu-rong	4

Table 3: Top Researchers Based on Patents Granted

Researcher	No. of Patents Granted	Affiliation
Cheng, Hai-feng	13	National University of Defense Technology
Liu, Hai-tao	12	National University of Defense Technology
Pottier, Agnes	10	Nanobiotix Co., Ltd.
Levy, Laurent	10	Nanobiotix Co., Ltd.
Meyre, Marie-Edith	10	Nanobiotix Co., Ltd.
Cao, Tun	10	Dalian University of Technology
Zhou, Yong-jiang	10	National University of Defense Technology
Cui, Hua-gang	9	Hengyang Tellhow Communication Vehicles Co., Ltd.
Yao, Jun-feng	8	Shanghai Smartee Denti-Technology Co., Ltd.
Zhang, Chao-yang	8	National University of Defense Technology

2.1.2 Patent Trends by Top Countries

According to the Derwent database, China, the United States, and Japan are the top patent holders in LO research. Based on data from Derwent, the number of patents issued in each country from 2016 to the present has increased each year, suggesting LO research is on the rise (shown in Figure 1).

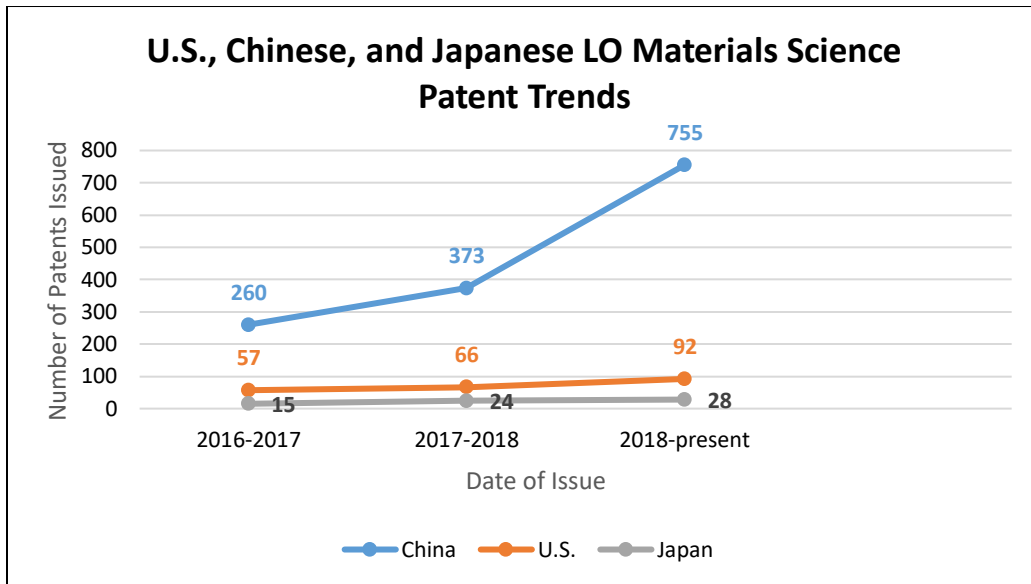


Figure 1: Graph of U.S., Chinese, and Japanese Patent Trends.

2.1.3 Patents Pending

The top researchers and their affiliations based on the number of pending LO patent applications without grants is shown in Table 4. Using the same terms as before, the search was limited to alive and indeterminate patents from 2016 to the present. Indeterminate patents were included because it was unclear whether they were dead or alive.

Table 4: Top Researchers Based on Pending Patents

Researcher	No. of Pending Patents	Affiliation
Cao, Tun	31	Dalian University of Technology
Zhou, Jian-jing	17	Nanjing University of Aeronautics and Astronautics
Yamashita, Shigeyuki	17	Lintec, Corporated
Junkers, Eric P.	15	Hytorc Division, UNEX Corporation
Junkers, John K.	14	Hytorc Division, UNEX Corporation
Wang, Fei	14	Nanjing University of Aeronautics and Astronautics
Shi, Chen-guang	13	Nanjing University of Aeronautics and Astronautics
Zhang, Xiaoxing	12	Hytorc Division, UNEX Corporation
Li, Hai-lin	12	Nanjing University of Aeronautics and Astronautics
Wang, Feng	12	Hengyang Tellhow Communication Vehicles Co. Ltd. Nanjing University of Aeronautics and Astronautics

2.2 TOP RESEARCHERS/ORGANIZATIONS BASED ON PUBLICATIONS AND CITATIONS

2.2.1 Scopus Search Results

DSIAC also used Scopus, a literature database, to search for researchers and organizations working in hypersonics and patents related to hypersonics. Scopus is the largest curated abstract and citation database of peer-reviewed literature, containing over 71 million records, 23,000 peer-reviewed journals, and more than 166,000 books. Scopus uses sophisticated search tools that can search by document, author, or affiliation and can refine results by source type, year, language, author, affiliation, and more. As with other search engines, Boolean logic can narrow the number of citations to more relevant results. Scopus also contains hundreds of thousands of engineering conference papers not covered in alternative databases [1].

Using the same search terms as in the patent search, the Scopus search was also limited to publications from 2016 to the present. The top organizations are shown in Table 5, and the top researchers are shown in Table 6. The rankings are based on number of publications and citations per organization/researcher. The h-index metric is also included as an attempt to measure the productivity and citation impact of the publications of the researchers. The h-index is based on an author's number of publications and citations to provide an estimate of the importance and impact of his/her research contributions. The h-index means a researcher has index h if h of his/her publications have at least h citations each. For example, an h-index of

15 means that 15 of the author’s publications have received at least 15 citations each. The higher the h-index, the more credible the research.

Table 5 identifies the top organizations based on the number of publications, with the top researcher(s) from the associated organization. Ten of the top researchers identified in bold in Table 5 are can also be found in Table 6, which identifies top researchers based on number of publications.

Table 5: Top Organizations Based on the Number of Publications

Organization	No. of Documents	Top Researcher(s)	No. of Documents	No. of Citations	h-Index
Ministry of Education China	43	Cao, Weiping	2	32	9
Northwestern Polytechnical University	39	Zhou, Li	5	16	7
Air Force Engineering University, China	37	Qu, Shaobo	11	47	39
		Wang, Jiafu	9	47	32
		Pang, Yongqiang	8	47	18
		Zhang, Jieqiu	7	41	21
National University of Defense Technology	30	Liu, Ruihuang	7	3	1
		Zhao, Dapeng	7	19	7
Nanjing University of Aeronautics and Astronautics	27	Jiang, Tian	7	68	22
		Xu, Guoyue	7	17	22
Chinese Academy of Sciences	26	Luo, Xiangang	6	45	51
Beihang University	22	Huang, Jun	7	6	10
Beijing Institute of Technology	22	Fang, Daining	3	24	43
Xi’an Jiaotong University	19	Zhang, Anxue	8	5	18
Harbin Institute of Technology	19	Wen, Guangwu	3	11	23

Table 6: Top Researchers Based on Scopus Publications and Citations

Researcher	Affiliation	No. of Documents	No. of Citations	h-Index
Qu, Shaobo	Air Force Engineering University, China	11	47	39
Wang, Jiafu	Air Force Engineering University, China	9	47	32
Pang, Yongqiang	Air Force Engineering University, China & Xi'an Jiaotong University, China	8	47	18
Zhang, Anxue	Xi'an Jiaotong University, China	8	5	18
Baskey, Himangshu Bhusan	Indian Institute of Technology	7	24	9
Brookner, Eli	Raytheon	7	9	14
Chen, Juan	Xi'an Jiaotong University, China	7	4	9
Jiang, Tian	Nanjing University, China	7	68	22
Singh, Dharmendar Kumar	Indian Institute of Technology	7	45	25
Liu, Ruihuang	National University of Defense Technology, China	7	3	1
Panwar, Ravi	Pandit Dwarka Prasad Mishra Indian Institute of Information Technology, Design and Manufacturing, India	7	57	9
Xu, Guoyue	Nanjing University, China	7	17	22
Zhang, Jieqiu	Air Force Engineering University, China	7	41	21
Zhao, Dapeng	National University of Defense Technology, China	7	19	7
Huang, Jun	Beihang University, China	7	6	10

2.2.2 WoS Search Results

WoS provides access to research literature linked to a rigorously selected core of journals, ensuring a unique combination of discovery through captured metadata and citation connections. The WoS Core Collection provides over one billion cited reference connections indexed from high-quality, peer-reviewed journals, books, and proceedings from 1900 to the present.

WoS was the final database used by DSIAC to search for top global researchers and organizations in hypersonics. The top researchers and organizations identified via the WoS search are shown in Tables 7 and 8, respectively. The same search terms were applied to the WoS search, with this search also being limited to publications from 2016 to the present.

Table 7: Top Researchers in WoS

Researcher	Affiliation	No. of Documents
Li, Xiong	Chinese Academy of Sciences	12
Qu, Shaobo	Air Force Engineering University, China	12
Wang, Jia-Fu	Air Force Engineering University, China	11
Pang, Yongqiang	Air Force Engineering University, China	10
Singh, Dharmendra	Indian Institute of Technology, Roorkee, India	10
Li, Guanyong	Chinese Academy of Sciences	10
Zhang, Yin	Nanjing University, School of Information Engineering	9
Liu, Yujia	Chinese Academy of Sciences	9
Wang, Jian-wei	Chinese Academy of Sciences	9
Zhang, Jing	Chinese Academy of Sciences	9

Table 8: Top Organizations in WoS

Organization	No. of Documents	No. of Citations
Chinese Academy of Sciences	36	238
Air Force Engineering University	23	108
Northwestern Polytechnical University	21	307
Centre National de La Recherche Scientifique, France	21	113
Indian Institute of Technology System	20	141
Nanjing University of Aeronautics Astronautics	19	56
Xi'an Jiaotong University	16	83
Zhejiang University	16	284
Beijing Institute of Technology	15	145
Monashi University	15	127
National University of Defense Technology, China	15	82

2.3 SEARCH RESULTS ANALYSIS

There were two different metrics used to search top global researchers in LO material science research—the number of patents and the number of publications and citations. When comparing the searches, zero organizations appeared in the search results of each database.

The following organizations appeared in the search results of at least two of the databases:

- Harbin Institute of Technology, China
- Air Force Engineering University, China
- Chinese Academy of Sciences
- Beijing Institute of Technology
- Xi'an Jiaotong University

There were no researchers that appeared in all our database search results. Two researchers appeared in the search results of at least two of the databases, Tun Cao and Dharmendra Singh. Tun Cao is affiliated with Dalian University of Technology and has been awarded 10 patents. He currently has 31 pending patents, suggesting he is a key researcher in current LO material science. Dharmendra Singh is affiliated with the Indian Institute of Technology and had some of the top publications in Scopus and Derwent databases.

A potential point of interest is that even after multiple rounds of filtering search results, many medical patents and publications were in the final search results. The technology being used in medical applications may or may not prove applicable to LO material science applications being sought in the military. However, the medical use of LO materials may be worth exploring.

REFERENCES

[1] Elsevier. "Scopus. An Eye on Global Research: 5,000 Publishers. Over 71M Records and 23,700 Titles." <https://www.elsevier.com/solutions/scopus/how-scopus-works>, 24 October 2019.