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A Comparative Study on Scientometric Indicators in Papers and Patents: A Case Study on Graphene

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ABSTRACT

- In this study, we intend to perform **a comparative study of paper and patent indicators focusing on graphene research** which has been widely studied not only in the basic science but also in industrial applications in recent 15 years.
- We used the **'Insightful Integrated Indicators Metrics(i*Metrics)' system developed by Korea Institute of Science & Technology Information (KISTI).**
- The selected 10 scientometric indicators are calculated **to identify research productivity, impact, collaboration and technological convergence by country.**
- The mapping and clustering based on the similarity of the computed indicators is carried out to **characterize the country profiles on graphene research**.

DATA

- Publication source : SCOPUS DB constructed by KISTI
- Patent source : USPTO of PATSTAT DB
- By search queries made of keywords with 'graphene' for publication year from 2000 to 2016
- Papers : 99,987 / Patents : 4,066

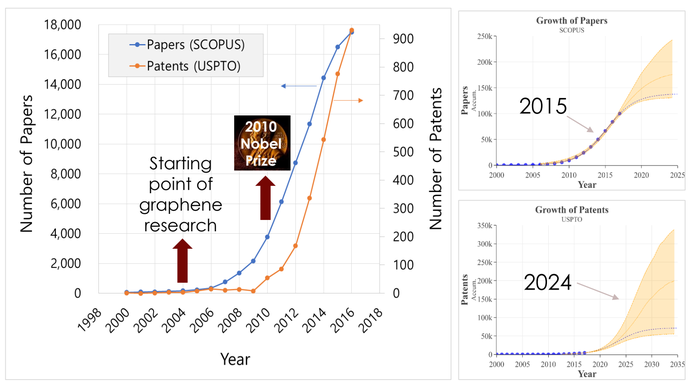
TOOLS

- Insightful Integrated Indicators Metrics (i*Metrics) system developed by KISTI for calculating indicators
- VOSviewer of CWTS for mapping and clustering

RESULTS & DISCUSSION

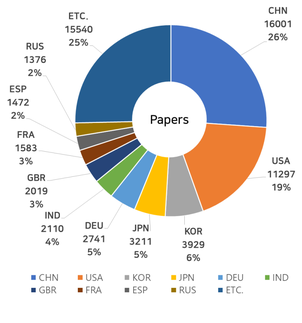
Productivity

- Number of Papers/Patents(NP)
- CAGR

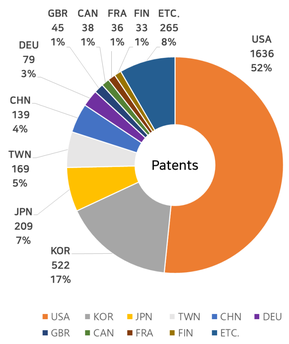


- The number of papers are increasing rapidly since 2004 when A. K. Geim and K. S. Novoselov, the winner of 2010 Nobel Prize in physics, extracted a single-atom-thick crystallite from bulk graphites(Geim and Novoselov, 2004).
- Meanwhile, the increase in patents starts a little later due to the time lag between the fundamental researches and industrial applications.
- From growth pattern, we can expect that the development of research on graphene is at a leaping stage now and the possibility of commercialization is growing.

Distribution of the number of papers By countries



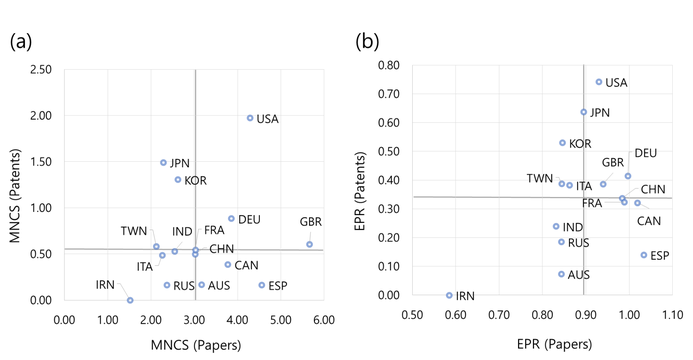
Distribution of the number of patents By countries



- The research papers on graphene have been published in 110 countries and the USPTO application countries are 48 countries.
- China has the largest number of papers, followed by the United States, South Korea, and Japan. However, the United States has more than 50% share in patents, followed by South Korea and Japan.

Influence & Excellence

- Mean Normalized Citation Score(MNCS)
- Excellence Paper/Patent Rate(EPR)



❖ MNCS (Waltman *et al*., 2011) and EPR (Bornmann *et al*., 2013)

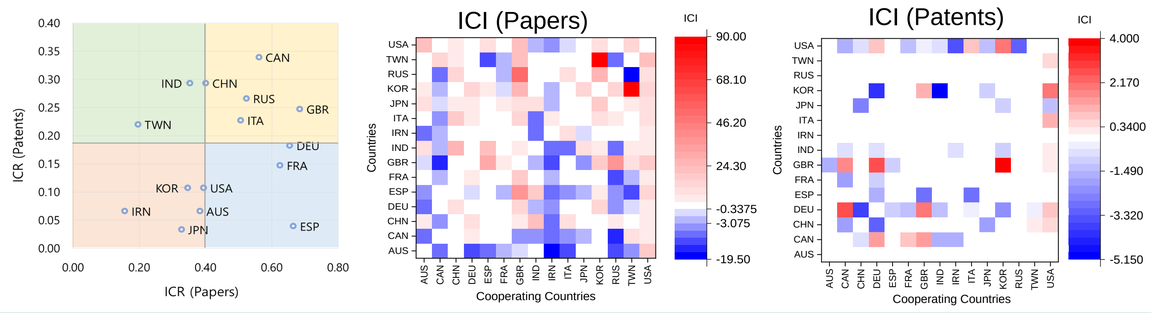
❖ The quadrant base line was formed by the median values of 15 countries.

- The USA, the UK and Germany are at the first quadrant for both of MNCS and EPR.
- The UK's MNCS value of the paper is 5.7, which is highest value but the UK's MNCS value of the patent is not relatively high.
- The USA, Japan, and South Korea which has many patents, the MNCS value of the patent was also high. The positions of countries on EPR were almost similar with those of MNCS

Networking & Collaboration

- International Collaboration Rate(ICR)
- Incremental Citation Impact(ICI)

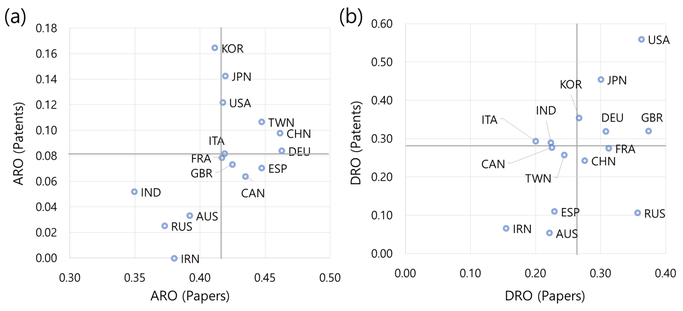
❖ ICI (Inzelt *et al*., 2009)



- The productivity of Canada and Russia is relatively low in both of papers and patents, but the ICR values of them are high which is placed at first quadrant.
- Taiwan and South Korea have a considerable citation impact as shown in the ICI indicator for papers.
- Russia shows the high cooperative effect with the UK. This can be considered the effect of Novoselov from Russia, who won the Nobel prize with Geim.
- South Korea and USA cooperate well together in a case of patents, and UK gains the benefit by cooperation with Korea and Germany.

Convergence & Diffusion

- Absorption Rate from Other Fields(ARO)
- Diffusion Rate to Other Fields(DRO)



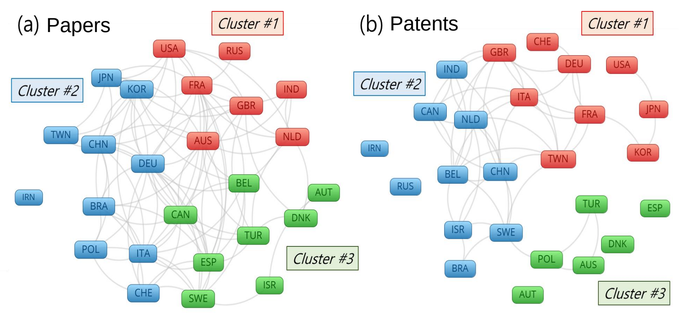
❖ The ARO and DRO are defined as the ratio of other fields in cited references and citing publications, respectively.

❖ This indicators are similar with the approach to measure researcher interdisciplinarity reported by Porter *et al*.(2007).

- The DRO of countries with high productivity and influence, such as the USA, Japan, and the UK were all high in papers and patents.
- This means that leading countries in graphene technology are leading the diffusion of knowledge in both the basics and application areas.
- The latecomers such as Korea and China show that they actively absorb knowledge in both basic and applied areas.

SUMMARY

Mapping & Clustering using the Similarity Profile Vector of Indicators



- Mapping and clustering were performed on the top-25 countries based on the similarity of the profile vector composed of five indicators(MNCS, EPR, ICR, ARO and DRO) of each country.
- South Korea, Japan and Taiwan are clustered in a same group(cluster #2 for papers; cluster #1 for patents). This implies that they are leading in industrial applications although they are latecomers in basic research on graphene research area.

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