La nanotecnología desde una perspectiva bibliométrica e informacional

Nanotechnology from the bibliometric and informational perspectives

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Resumen:

INTRODUCCIÓN: La nanotecnología y las nanociencias emergieron como el campo tecnológico en expansión en el siglo XXI. Sin embargo, las características de sus revistas y sus contribuciones a la ciencia de la información no han sido bien establecidas.

OBJETIVO: Describir las tendencias informacionales principales de las revistas sobre nanociencias y la nanotecnología.

METODOLOGÍA: Se analizó la evolución de los descriptores MeSH asociados con el campo, la obsolescencia de la literatura citada en algunas de las revistas indizadas en la Web de la Ciencia, y el grupo de revistas indizadas en Scopus, en base a indicadores bibliométricos básicos. Se mapeó los clústeres temáticos (VOS viewer, versión 1.6.2), a partir de 103 323

RESULTADOS: Prevaleció el enfoque bottom-up en la evolución de los descriptores en el MeSH, con ‘nanomaterial’ y ‘nanostructure’ como los más representativos. Las revistas nano se consolidaron en la primera década del siglo XXI, con nuevos tipos de artículos, un periodo de obsolescencia de la literatura que es la mitad del que muestran revistas de campos científicos de ciencia normal. El ecosistema de revistas en Scopus está bien representado. Los clústeres temáticos en 2000-2015 mostraron los desarrollos y tecnologías clave más relevantes, incluso para la Ciencia de la Información.

CONCLUSIONES: Se proporcionan estrategias para el análisis sistemático de desarrollos futuros en el campo de las nanociencias y la nanotecnología.

Palabras clave: nanotecnología, nanociencia, bibliometría, descriptores, mapeo de la ciencia

Abstract:

INTRODUCTION: Nanotechnology and nanosciences have emerged as the leading technological field of the XXI century. However, their contributions to the information sciences and the properties of their journals have been occluded by the vast amount of technical results of this data-intensive scientific field, in spite of its development as research field.

目的: To describe the development of the field of nanoscience and nanotechnology from the bibliometric perspective from its journals indexed in the Pubmed, Scopus and WoS databases, and their contribution to the field of Information Science.

METHODOLOGY: The timeline of related MeSH descriptors in Pubmed was established, journal obsolescence of the leading journals in WoS analyzed and the specialized journals in Scopus studied for basic output and citation indicators. The scientific production in Pubmed in the period 2000-2015 was analyzed by clustering and mapping techniques by...
using VOSviewer 1.6.2. The top cited literature in 2014 and 2015 was also analyzed for emerging trends.

RESULTS: The bottom-up approach prevailed on the descriptor evolution as observed in MeSH. The most inclusive terms for the research output were nanomaterial and nanostructure. Nanojournals consolidated in the first decade of the XXI century, contributing with new article types and half the obsolescence of normal science journals, with a well-represented ecosystem. Subject clusters were established in the 2000-2015 period, together with developments relevant for Information Science.

CONCLUSIONS: Our results provide strategies to systematically analyze future developments on nanoscience and nanotechnology.

Keywords: nanotechnology, nanoscience, bibliometrics, science mapping

Introduction

Nanotechnology and nanosciences have emerged as the present time transdisciplinary, technological revolution. However, this nano-revolution is very difficult to summarize, comprehend and systematize, due to the huge variety in experimental approaches. Moreover, the technical view normally overlaps its impacts in science as a corpus, inherent to its very data-intensive nature.

Nanotechnology has been early and systematically addressed since 1995 (Porter, 1995) from the bibliometric perspective, by renowned specialists in information science such as Leysderdorff (2005), Raffols (Kay et al., 2013) and Porter (Arora et al., 2013), or even in Cuba by Arencibia et al. (2005), either by simple output indicators, cocitation analysis from patent-cited literature or by text-mining techniques to discover new developments. Moreover, the appearance of highly and productive journals on this disciplinary area has posed a challenge for traditional publication models in terms of information obsolescence and
publication formats. Particularly in subject mapping, the expert review focus has been partially relegated by technological and innovation platforms analyses.

In order to provide a more integrative informational view of nanotechnology from the informational perspective, in this work, we analyzed the scientific output indexed in Medline database data on nanotechnology, based on descriptor emergence, followed by co-word analysis. The journals on this research area indexed in Scopus were also characterized attending to basic bibliometric indicators, together with major documentary typologies. And subject mapping techniques were also applied to identify major technologies and advances in this research area, mostly in the field of nanobiotechnology. Other contributions relevant for information storage and retrieval were also identified.

**Methodology**

The MeSH controlled vocabulary of Pubmed was analyzed for the timeline progression of descriptors related to subject area from 2000 to 2016. The most representative descriptors were set to characterize the subject trends in the field. The scientific output was characterized for leading biomedicine and biotechnology journals, their publication patterns, paper formats, main subject areas and country distribution. Journals were comparatively studied attending to SJR, H index, Ndoc, Nref, Ncit, cites and references per doc, respectively. Additionally, the obsolescence of the literature was analyzed based on half-time citation in WoS to those of other academic fields. Additionally, the retrieved bibliographic records were analyzed for word co-occurrence with the VOS viewer software, version 1.6.2. Density and cluster mapping were obtained for the period analyzed, with time-trends progression based on hot keywords, in general and for nanobiotechnology. The metric approach was combined with expert review based on classic documentary analysis. A general representation of nanotechnology and nanoscience applications was generated, in terms of size, shape and structure determinants. Moreover, the main applications are presented, particularly those in biomedicine and information technology fields. This was complemented with data from prior bibliometric analysis on nanotechnology.
Results and discussion

Most relevant papers on nanotechnology have been published in disciplinary journals (physics, chemistry and nano-journals) and breakthroughs and major advances in top journals (Science and Nature) (Leydesdorff&Schank, 2008).

Significantly, literature obsolescence as measured by half citation from 1997 to 2013 in WoS was similar for Nano Letters and Nanotechnology journals as for the J Phys G NuclPartic journal from 3 to 4 years, characteristic of research-intensive science, half the obsolescence time of most established disciplinary fields of stationary science. Moreover, there were fast publication journals, such as Nano Letters, Journal of Physical Chemistry Letters and Nanoscale Research Letters. Noteworthy, in this last journal a new publication format was implemented, called ‘Nano ideas’, publishing well founded and conceptually challenging and supported ideas for the advancement of the field, regardless prior theoretical verification or experimental realization. This format is consistent with other very small minimal publishable units as those of hypothesis or data journals, as an expression of microdocumentation. Besides, there appeared disciplinary journals related to the sociology of science, such as Recent Patents on Nanotechnology, Nanotechnology Law and Business, NanoEthics and Nanotechnology Perceptions, with the exception of not any systematic reviews journal in a field so diverse. All these journal types complemented the journals’ cluster publishing in nanotechnology journal domain in Scopus. Moreover, journal partnering for concerted evaluation and cascading of manuscripts falling outside each journal domain was recently implemented between Nano Letters and ACS Nano, according to the ‘comprehensive article’ definition at ACS Nano, without setting strict manuscript lengths in detailed journal guidelines.

Regarding descriptor evolution, subject-specific bibliometric and scientometricstudies in nanotechnology have focused on nano-prefix terms, combined with expert review. The terms vary in scope but focus on main materials and technological developments. Therefore, descriptors emerged in the early 1990’s and nano journals consolidated during the first
decade of the XXI century. Particularly in the Medline database, ‘Microchemistry’ (1991-2001; so called ‘bottom-up approach’) and ‘Miniaturization’ (1994-2001; ‘top-down approach’) was found to integrate under ‘Nanotechnology’ in 2001, with emphasis in biomedicine as expected in this subject database. A closer look into the keyword distribution from 2000 to 2015 identified ‘nanomaterial’ and ‘nanostructure’ and the leading descriptors for the field (Figure 1). Hence, searching for ‘nanostructure’ or nanomaterial in the title, abstract and keywords bibliographic fields, 103,323 bibliographic records were retrieved from Pubmed and further analyzed for term co-occurrence.

Figure 1. Descriptor representativeness in the PubmedMeSH controlled vocabulary for the scientific production on nanoscience and nanotechnology from 2000 to 2015.

A network of 707 terms with a minimal term frequency of 400 was generated, structured in six clusters: i) nanostructures and nanocomposites; ii) tissue culture and in vivo testing models; iii) microparticles, polymers and formulations; iv) protein and energy transfer systems; v) metal-ion
nanoparticles and toxicity and vi) nanofibers, scaffolds and its mechanical properties. The most intense and recent research was focused on graphene materials, silver and gold nanoparticles, toxicity evaluations and the quantum crystal state (Figure 2).

Figure 2. Density and cluster mapping views for terms identified in the title and abstract fields of bibliographic recordson nanoscience and nanotechnology retrieved from Pubmed in the period 2000-2015. ‘Nanomaterial’ was used as search strategy. Networks and maps were generated in VOS viewer version 1.6.2, with the association strength clustering algorithm.
Examples of successful applications been approved by regulatory medical agencies were identified. Specifically in the biomedical field, nanocarriers for different drugs, in medical imaging (nanotheranostics), nanovaccinology and insulin delivery were shown. Core technologies comprised: rolling circle amplification of DNA and RNA molecules, peptide nanotubes, nanobodies, protein corona studies and nanopore sequencing. Significantly, this last resulted in the drastic reduction of DNA sequencing costs, indirectly potentiating initiatives for long term information storage in and retrieval from DNA molecules, and challenging the Moore’s law for using DNA in data storage.

Additionally, nanoprinting (nanolithography; the Gutensberg’ printing technique but at nanometric scale) emerged for microchemistry and nanoscale circuitry fabrication, as well as biosensors and nanometric structures for sensing and retrieving physical and biological information. Some approaches addressed multilayered information storage and retrieval at nanoscale, but facing the challenge of the classical diffraction limit. Subject, ontology-based data repositories have also been implemented.

Developments include nanotechnology applications in information devices (displays and batteries) and ICT applications (data storage, computer chips, nanometrology and optoelectronis), together with its use in industrial manufacturing.

**Conclusions**

The study describes the journal ecosystem in nanotechnology and nanosciences, the cluster of journals indexed in Scopus and Pubmed, and publication trends on this topic. Remarkably, there have arisenfield-specific document types and sociology-related journals. Moreover, emerging techniques regarding biology, genetics and nanometric applicable techniques would also impact in Information Science development, particularly storage and retrieval.
Bibliography


