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Global nanotechnology research literature overview☆

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Abstract

Text mining was used to extract technical intelligence from the open source global nanotechnology and nanoscience research literature (SCI/SSCI databases). Identified were: (1) the nanotechnology/nanoscience research literature infrastructure (prolific authors, key journals/institutions/countries, most cited authors/journals/documents); (2) the technical structure (pervasive technical thrusts and their inter-relationships); (3) nanotechnology instruments and their relationships; (4) potential nanotechnology applications, (5) potential health impacts and applications; and (6) seminal nanotechnology literature. Our results are summarized in this paper.
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Keywords: Nanoparticle; Nanotube; Nanotechnology; Text mining; Bibliometrics; Document clustering

1. Introduction

This paper is a summary of our much longer report [1].

Nanotechnology is booming! In the global fundamental nanotechnology research literature as represented by the Science Citation Index/Social Science Citation Index (SCI/SSCI) [2], global nanotechnology publications grew dramatically in the last two decades.

Due to this exponential growth of the global open nanotechnology literature, there is need for gaining an integrated quantitative perspective on the state of this literature. In 2003–2005, a comprehensive text

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mining study was performed to overview the technical structure and infrastructure of the global nanotechnology research literature, as well as the seminal nanotechnology literature [3,4]. Based on the wide-scale interest generated by these reports, it was decided to update and expand the study using more recent data, a much more comprehensive query, and more sophisticated analytical tools.

In the updated study, text mining was used to extract technical intelligence from the open source global nanotechnology and nanoscience research literature (SCI/SSCI databases). Identified were: (1) the nanotechnology/nanoscience research literature infrastructure (prolific authors, key journals/institutions/countries, most cited authors/journals/documents); (2) the technical structure (pervasive technical thrusts and their inter-relationships); (3) nanotechnology instruments and their relationships; (4) potential nanotechnology applications, (5) potential health impacts and applications; and (6) seminal nanotechnology literature.

The authors provide in this paper the highlights of our comprehensive study [1], *including the production efficiency of seminal nanotechnology documents*. The results are divided into four main sections: Infrastructure; Technical Structure; Instrumentation; and Applications. In turn, Applications are divided into non-medical and medical. The results will be presented in the order listed above. Then, the *seminal nanotechnology literature production efficiency* will be presented.

Infrastructure describes the performers of nanoscience/nanotechnology research at different levels, ranging from individual to national performers, and it includes the archived literature as well. *Technical Structure* identifies the pervasive technical thrusts (and their inter-relationships) of the nanoscience/nanotechnology literature. *Instrumentation* provides both the infrastructure and technical structure of the sub-set of the nanoscience/nanotechnology literature that addresses specific instruments. Finally, *Applications* provides the infrastructure and taxonomy of the sub-set of the nanoscience/nanotechnology literature that addresses specific non-medical and medical applications.

2. The promise of nanotechnology

Broadly speaking, nanotechnology is the development and use of techniques to study physical phenomena and construct structures in the physical size range of 1–100 nanometers (nm), as well as the incorporation of these structures into applications. Although size is a convenient way of defining the area, it alone is not enough to distinguish the nanoscale material from microscopic material. For example, there is no line of demarcation that separates structures at 120 nm from that of 100 nm. In practice, nanotechnology has more to do with the investigation of novel properties that manifest themselves at that size scale, and of the ability to manipulate and artificially construct structures at that scale. Experiments and computer simulation have been targeted at very small scales for decades. The advances in high speed and high storage capacity computers, as well as accurate instruments for measuring and manipulating at the nanoscale, have accelerated the development of nanoscale structures and devices into reality.

The science that underlies nanotechnology can be traced back to the early days of the 19th century. Kostoff et al. used the citation-assisted background (CAB) approach [5] to trace the rich scientific heritage of nanotechnology back to its earliest roots [1]. The interested reader is strongly advised to access this ~1500 page reference.

Predictions about the promise of nanotechnology can be traced back to Feynman's classic 1959 talk [6], where he stated: "The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom." Feynman proceeded to describe building with atomic precision, and outlined a pathway involving a series of increasingly smaller machines.