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NANOMATERIALS IN SPACE: TECHNOLOGY INNOVATION & ECONOMIC TRENDS

Abstract

Nanomaterials and nanostructures have a broad impact on space missions and programs (e.g. launchers, planetary science and exploration). Their main benefits are related to reduced vehicle mass improved functionality and durability of space systems and increased propulsion performance. For these reasons, in this paper, we would like to explore the recent evolutions of nanomaterials and nanostructures for space systems, with a focus on patents and market trends related to lightweight structures, damage-tolerant nano-scale systems, nano-coatings and adhesives, nanomaterials and structures for thermal protection and control. Our analysis examines patent information from a database containing more than 54M worldwide patent families and combines the data retrieved with market indicators. Such evaluation is useful to assess the technological trends and evaluate their current stage of maturity, within the overall Technology Life Cycle. By using specific sectoral keywords, our study takes into consideration about 1000 patent data on nano-structures, materials and processes for space applications evaluating, among others, patents trends (2010-2019), International Patent Classifications, country distribution, top assignees, legal state, forward and backward citations. As a result, we can assess which International Patent Classification is more common and which geographical area is more active. In the area under investigation, we identified that ceramics and similar materials (C04B) are widely protected as well as heterocyclic compounds (C07D) and spacecraft and its related equipment (B64G). For what the geographical distribution is concerned, while China and United States confirm their predominance, it is worthwhile noticing that Canada, one of ESA Member States, is highly active as well. Our focus on the European patenting activity shows that Great Britain, Germany and France are the most active countries. From the analysis of the other indicators (e.g. citations, assignees, etc.), we can assess which type of nanomaterial and nanostructure for space applications is growing more rapidly. Furthermore, patent indicators, integrated with market information, provide a clear evaluation of the related technology trends and readiness level. In conclusion, patents metrics provide a valuable asset to measure innovation performance. This data can also be used to monitor activities of worldwide players, create a performance evaluation system in RD entities and foresee specific technological trends. Thanks to this type of analysis we can capture differences in innovation performances. The resulting indicators support strategic roadmapping and contribute in mapping knowledge and competences worldwide. In addition, they provide information on technological gaps and possible opportunities, measuring the results of space valorisation and technology transfer.