

Tech Mining to Validate and Refine a Technology Roadmap

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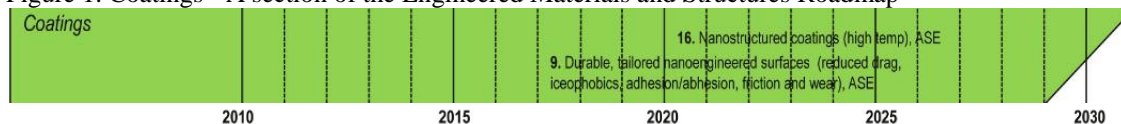
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Introduction

In 2012, the National Aeronautics and Space Administration (NASA) agency specialists along with the help of the National Research Council (NRC) developed a set of roadmaps covering fourteen technology areas [<http://www.nasa.gov/offices/oct/home/roadmaps/index.html>]. These roadmaps contain the near-term space technology needs, longer term challenges, NASA's space technology activities prioritization, and overall technology investment strategy.

Considering the fact that NASA involved agency experts in developing the roadmaps and contracted with NRC to get recommendations, we can say the roadmapping process seems to be highly based on experts' opinion, which may be influenced by subjective elements and limited cognitive horizons. Moreover, NASA stated that they intend to revise those roadmaps on a regular basis. This motivates us to undertake this study where we consider a section namely nanocomposite coatings of the roadmap -- Engineered Materials and Structures Roadmap (excerpted from Nanotechnology Roadmap, Technology Area 10, National Aeronautics and Space Administration, April 2012) as shown in Figure 1 and use 'tech mining' (Porter 2005) to validate its content and refine it. We intend to validate the emergence of nanocomposite coatings related technologies by exploring R&D and innovation activities in those areas. By analyzing the growth of related publications and patents, we try to find quantitative evidence to judge the predictions made by the experts. Also, we mine publication and patent records to derive topical intelligence. We analyze the trends of the topics and try to find out the emerging ones that would help refine this particular section of the roadmap.

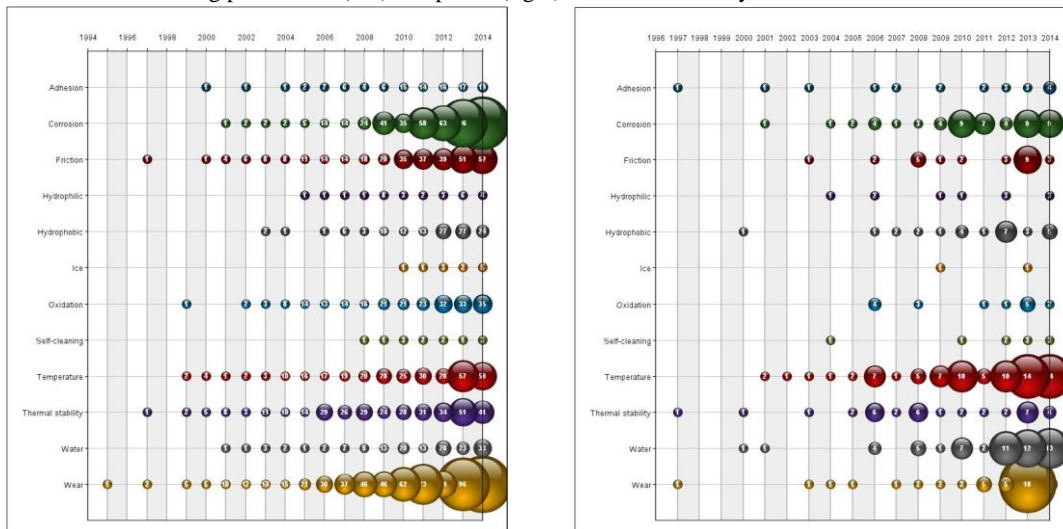
Figure 1. Coatings - A section of the Engineered Materials and Structures Roadmap



Data and Methodology

In order to collect information on developmental status of the nanocomposite coatings related technologies, we consider research papers and patents published between 1995 and 2014. We utilize Web of ScienceTM Core Collection and Derwent Innovations IndexSM databases (accessed through Georgia Tech Library, March 2015) to obtain 2465 publication and 289 patent records respectively. Using VantagePoint [www.thevantagepoint.com] text mining software, we extract keywords by applying Natural Language Processing (NLP) to the publication and patent records. Among those keywords, we look for the terms and phrases similar to the ones contained in Figure 1 and analyze their trends as shown in Figure 2. Also, using ClusterSuite (O'Brien et al. 2013) and Factor Map in VantagePoint, we perform keywords' clustering and generate topical intelligence. We examine the trends of the topics and identify the emerging ones.

Figure 2: Bubble chart showing publication (left) and patent (right) trends for each keyword over time



Source: 2465 publication records excerpted from Web of Science™, 1995-2014 (accessed March 2015)

Source: 289 patent records excerpted from Derwent Innovations Index, 1995-2014 (accessed March 2015)

Roadmap Section Validation and Refinement

After analyzing the developmental trends of the specific technology areas and topical factors, our comments towards validation and recommendations towards refinement of the target roadmap section are as follows:

- Considering the substantially increasing publication activity in the area of nanocomposite coatings with high temperature applications, but a minimal amount of patenting activity, it is expected that it would take 10-12 years from 2015 for the maturation of these coatings. These coatings would be more thermally stable and have high-temperature tribological applications. Hence, the prediction as made in the roadmap seems likely to prove right. Also, the generated topical intelligence suggests that yttria-stabilized zirconia, silicon carbide, and ceramic based, and diamond-like nanocomposite coatings, and high-velocity oxyfuel coating fabrication technique will be of interest. This additional information could contribute towards refinement of the roadmap section.
- Although there has been a growing research interest in the area of nanocomposite coatings with reduced drag/friction and increased wear resistance, patenting activity is not that high. Also, there has not been a significant publication and patenting activity in the area of nanocomposite coatings having good adhesion property and ice-phobicity. As revealed by topical intelligence, superhydrophobic nanocomposite coatings have been well researched and have a few patents but the study of their ice-phobic nature still needs attention. These give enough evidence to disagree with the prediction shown in the roadmap. Keeping in mind the current research and development status, the maturation of these coatings should start from 2020 approximately. Topical intelligence obtained using tech mining points towards electroless, diamond-like carbon, multi-element nitride and yttria-stabilized zirconia nanocomposite coatings, and high-velocity oxyfuel coating fabrication technique as the emerging technologies. We believe that such empirical information can help refine this technology roadmap. More generally, we recommend tech mining as a means to inform roadmapping, both when creating a new roadmap and to check progress.

References

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