

Innovation and business growth in a strategic emerging technology: New methods for real-time intelligence on graphene enterprise development and commercialization

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This paper presents the results of research to develop new data sources and methods for real-time intelligence to understand and map enterprise development and commercialization in a rapidly emerging and growing new technology.

Updated and validated information on trajectories and developments in innovation in new technologies is vital today for business, researchers and research managers, sponsors and funders, and policymakers. In the world of innovation, sources of information about business and commercialization strategies are often fragmented. Surveys of businesses have inherent time lags and may not be available on a comparative cross-country basis, while proprietary studies are often selective (and expensive). The analysis of patents is a frequently-used method and although helpful also has well-known limitations, including measuring invention rather than process or downstream product innovation and not capturing the innovation strategies of smaller technology-oriented companies who may not patent. The strategies of these smaller firms may be especially relevant in promoting discontinuous and more radical approaches to innovation. Paradoxically, increasing amounts of information about such firms is available through unstructured online sources. Yet, processing and analyzing that information can be complex and difficult to manage through reasons of its global scope, sheer size, and unstructured nature.

The paper draws on research that is developing novel and scalable methods to mine and combine information from unstructured online sources including enterprise webpages, established structured databases including data on patenting, and qualitative information. The promise of this strategy is that it combines up-to-date online data sources, including fast-breaking streams, with available structured data and interview insights so as to allow the development of real-time and on-going monitoring, mapping and analysis. The research focuses on enterprise development and commercialization strategies in graphene. This is a nanoscale two-dimensional material with exceptional properties holding great potential for path-breaking applications across a range of application areas including electronic memory and semiconductors, fillers and composites, displays, biomaterials and sensors, batteries, medical applications, and coatings. Public and private investment in graphene has grown over the past few years. The field is expanding rapidly, with thousands of new patents and hundreds of companies already entering the graphene domain.

However, although there is rising worldwide interest in graphene, there are questions about the positioning of this emerging technology and the extent to which promised applications will actually materialize. Emerging technologies, such as graphene, frequently go through one or phases of excitement marked by sharp increases in expectations, interest and investment, followed by periods of uncertainty and loss. This cycle of hype may eventually result in the realization of productivity and innovation advances, including through ways not initially expected at the start of the process. Such cycle or wave concepts are useful in the ex post analysis of emerging technologies, but are limited in predictive power. In the paper, we propose two improvements. First, we argue that analysis of an emerging technology should give more attention to deeper structural characteristics such as the evolution of the value chain rather than focusing on surface-level aggregated trends. Second, we demonstrate how online information about firms active in an emerging technology through web content mining can introduce novel additional

intelligence capabilities. In the paper, we systematically analyze the development and commercialization strategies of 74 firms through web content mining, structure data analysis, and qualitative analysis. We show how graphene commercial activity is moving from the production of graphene materials to intermediate and final products, examine shifts towards more specialized applications, and investigate implications for business and policy. Although the paper is focused on graphene, the approaches and methods developed are applicable to other emerging strategic new technologies.