FROST & SULLIVAN

NanoMech®

2018 North American Nanocoatings Technology Innovation Award

2018
BEST PRACTICES
AWARDS

Contents

Background and Company Performance

Industry Challenges

Extreme pressure conditions, exposure to hazardous chemicals, and manufacturing imperfections shorten the lifecycle and increase maintenance requirements of industrial equipment and machinery. The performance of most lubricant and coating chemistries currently available to mitigate these issues are limited due to their inability to maintain uniform thickness and to coat complex component shapes. Conventional coatings, such as chrome-based solutions, demonstrate limited resistance to wear and corrosion, are very susceptible to pitting, and suffer other failures in high-stress and chemically intensive conditions. Also, conventional deposition processes are time-consuming and require multiple layers to achieve the required performance quality. This generally results in uneven surfaces and makes it difficult for machining. Another disadvantage is that hexavalent chromium is classified as a carcinogen, posing serious occupational and environmental hazards. In fact, the compound has been banned in many countries, leaving a market gap to be filled by advanced, efficient, and environmentally-friendly coatings that will eliminate both the quality and performance pitfalls of conventional coatings.

Protective coatings used on various industrial equipment and machinery must withstand the harshest conditions, and hence the need remains to develop solutions that will maximize asset lifecycle and productivity without compromising on performance. This scenario is applicable across industries including oil and gas, aerospace, automotive, and trucking that is rapidly evolving and must accommodate coating and lubrication solutions for both current and future market needs.

Also, lubricant and additive solutions have not kept up with the advances seen in the manufacturing, energy, and defense industries, and for any machine to operate smoothly, some medium such as coating must be provided for overcoming friction. Optimizing the energy loss by eliminating friction increases the performance and efficiency of machines. As such, the lubrication, additives, and equipment components (e.g., gears, bearings, and pistons) must be in synergy with each other. A major challenge coating manufacturers face is developing a product portfolio that can cater to these different industrial segments to help reduce maintenance costs for the various equipment.

The aforementioned challenges necessitate the development of lubrication, additive, and coating systems that are highly customizable and can meet every aspect of today's evolving needs across various industries and application scenarios.

Technology Attributes and Future Business Value

Industry Impact

NanoMech Inc. (NanoMech) has delivered a proprietary technology that combines nanocomposite materials, nanoparticle deposition systems, nanolubricants, and nano-engineered polymers in a single platform and then selectively utilizes specific features and capabilities to obtain protective solutions for various applications. Of particular note is the company's use of a proprietary process to create high-strength polymers reinforced with functionalized nanoparticles; also, it developed a process and materials that produce uniform and aesthetically appealing coating solutions. These innovative nanolubricants are encapsulated in oil and emulsifiers for obtaining stable anti-friction applications; in addition, the nanoparticles can be embedded into polymers to enable next-generation functionalities, such as anti-microbial activity.

NanoMech develops platform technologies based on nanotechnology used to develop customized solutions across industrial applications that match customers' needs, most of which are multi-national corporations. The nanotechnology-based coatings deliver better output by building a more robust surface, a protecting film with greater coverage on contacting surfaces for application in high-pressure conditions with boundary lubrication. The coatings also reduce wear by inducing asperities and polishing contacting surfaces to increase durability.

The company offers a range of nanotechnology patent-protected products under its technology platform that are capable of addressing multi-functionality needs. The overall development of nanotechnology-based coating and lubrication solutions is focused on functionalized nanocomposites for applications requiring light-weight, very high strength performance.

Frost & Sullivan recognizes that NanoMech's breakthrough nanotechnology platform will revolutionize the machinery and equipment coatings industry and that the company stands out as industry leader for its solutions development and application flexibility.

Visionary Innovation

NanoMech, as a spin-off from the University of Arkansas (in 2002), is rooted in the research and development (R&D) and product commercialization of nanotechnology-based coatings and lubrication solutions. In 2014, after more than a decade of ideation to product stage development, the company started its own manufacturing unit to cater to a wide range of industries. Now, it has a stronghold on intellectual property for nanotechnology based coatings with over 2,500 patents and claims. Also, the issuance of numerous patents in the lubrication realm positions the company as technology leader in this segment.

NanoMech is the first nano-manufacturing company to receive ISO 9001:2015 certification, recognition of a formal quality management system. This certification ensures that the company's products adhere to robust quality management that both ensure customer satisfaction and continual product improvement. Frost & Sullivan understands the importance of quality management in an emerging field, especially considering this breakthrough technology platform facilitates the development of products that are highly customizable and promise to meet the varying demands of clients concerning particular friction requirements, film thickness, and temperature suitability.

The processes, techniques, and products developed by NanoMech help increase its clients' competitiveness in their respective fields. Frost & Sullivan recognizes the business impact that NanoMech's nanotechnology-based platform has on various industries as well as its ability to build a stronghold in oil and gas, trucking, automotive, manufacturing and other industries apart from growing its client base by solving new application challenges.

Product Impact

NanoMech has disrupted major markets with the delivery of a technology platform capable of developing multi-component chemistries at the sub-micron scale. The company has been able to valorize chemistries including organic, inorganic, solids, and liquids, which are molded into nanoscale industrially applicable materials to create an open architecture that can pack multifunctional chemistries. The nanotechnology enables high surface-to-volume ratios, pristine material properties, novel material behavior, and greater packing density. These features are possible because of the unprecedented ability to synthesize, deposit, manipulate, and integrate the novel materials at a nanoscale level for use in coatings and lubrication applications. This means the products can fight friction and wear under extremely harsh conditions with the help of a self-replenishment mechanism while the unique and complex chemistries can be tailored to fit almost any end-user requirement.

NanoMech has optimized its coatings development processes by leveraging years of interdisciplinary research with its team of nano-engineering scientists and experts. As a result, the company has mastered depositing a mix of additives at the surface that work in harmony by attaching onto the substrate. The coatings and additives boost the reliability of equipment or machinery performance efficiency by 200 to 1000%, which represents massive differentiation within the machinery sector.

After developing nanotechnology platforms, NanoMech has produced a unique portfolio of proprietary coatings and lubrication solutions such as AtomLube® and AtomOil®, which are used to increase the performance and safety aspects of all vehicles, but find significant application in the automobile sector. A key advantage of the products is that they are Self-replenishing and increase energy-efficiency by drastically

improving system performance. The company has developed nGlide®, a nano-engineered multi-component, multi-functional lubricant and lubricant additive technology that enables immediate performance improvements of up to 300% and beyond into machining industries, automobiles, pumps, power generation, and turbines. Its high endurance polymeric coatings are marketed under the names TuffTek® and GUARDx® respectively.

NanoMech delivers superior quality solutions for customers through its extensive product portfolio, and it upgrades itself every day to answer new customer requirements and challenges by developing the most suitable solutions that address their needs and requirements. Hence, Frost & Sullivan identifies NanoMech's technical expertise and its capability to disrupt machinery and equipment performance and efficiency by utilizing nanotechnology as the key to unlocking the potential of coating solutions. Frost & Sullivan believes that these futuristic nanotechnology-based solutions will drive the development of sustainable and eco-friendly coatings.

Application Diversity

NanoMech excels at developing products based on customers' requirements; hence partnerships with industry leaders hold the key to its entry into new application segments and forge unique collaborations with manufacturers. The company went commercial after its R&D stage about 4 years ago, and the science driven by nano-engineering and nano- manufacturing it developed is paving the road for next-generation coatings and lubrication solutions that are in demand in today's industrial arena.

Further, NanoMech customers' desire is to handle specifically targeted friction, so the company is committed to providing solutions with controlled, low friction properties that allow for decent slip during torque. NanoMech's solutions enable these characteristics and are applicable and customizable to a wide spectrum of industries.

The company's major focus is businesses that have a high demand for surface-protecting coatings and lubricants based on advanced materials and unique chemistries. Recently, NanoMech received investment by Saudi Aramco, which is the largest oil and gas company in the world. This global industry is a major demand source for the use of lubricants, greases, and pastes, and NanoMech solutions are an ideal fit as they enhance the lifespan of products in extremely corrosive and high-temperature conditions. These systems require coatings that exhibit no aggregation and enable a reduction of hydrate formation in pipelines. The oil and gas industry is worth trillions of dollars, and continual demand for NanoMech solutions beacons towards a high growth rate for the company.

NanoMech has strategically placed offices in Houston, Texas to cater to the demands of the ever-growing oil and gas hub; with developments in fracking, demand for

coatings is immense. Ready with its extensive product line, NanoMech is in a position to dominate the market as the leading coating solutions provider. The product differentiation that NanoMech brings into the picture is impeccable and has gained the trust of end users by proving its efficiency and capability.

In January 2017, collaboration with Pace Industries enabled NanoMech to enter into the die-casting industry. Because of the partnership, Pace Industries has been able to obtain quality control, repeatability, and scalability in its manufacturing process. Also, the company has extensive partnership with the US Army for the development of state-of-the-art soldier protective technologies. For example, nGuard nanocomposite--a patent-pending technology from NanoMech--makes Army Combat Uniforms water-repellent and completely immune to flash flames, insect pathogens (like Zika, Malaria, Yellow Fever, West Nile Virus, etc.), and microbes to protect soldiers deployed in various parts of the globe facing unfavorable environments.

In aerospace industries, NanoMech is able to offer a viable nanostructured surface engineering for its manufacturing requirements including high productivity and superb workpiece surface finish for its Ti-alloys, Ni-based alloys, Rene, and stacked Ni alloys. Application of TuffTek nanostructured surface engineering on carbide inserts cut the aerospace alloys 50% faster while providing excellent surface quality. Today major aerospace companies including General Electric are using TuffTek products to cut super strong materials, such as Ti-alloys and Ni-based alloys

Frost & Sullivan understands that each of these industrial segments requires a solution that promises to increase product lifecycle and efficiency. This need for nano-solutions is gaining immense traction as the technology can cater to multiple applications and synchronize with machines and equipment. When analyzing the competitive landscape, Frost & Sullivan finds that NanoMech's multi-solution applicability remains unmatched by most solutions in the market and helps customers upgrade and compete amongst their global peers.

Customer Acquisition

NanoMech's lubricants have gained the interest of many companies, exemplified by deals it signed with some of the world's most well-known names, such as GE Oil & Gas, Schlumberger-Cameron, Technip, and Baker Hughes. One major agreement is with FMC Technologies, a company that paints most of the oil and gas equipment across the world, assets used under the harshest conditions. This client gives NanoMech expansive reach across the offshore equipment coatings space.

Moreover, it has been recognized for innovation and product quality by the US Department of Energy, US Department of Defense, US National Science Foundation, US National Institute of Health, and US Environmental Protection Agency. Also, NanoMech has a strong list of world class investors. The company is starting another

investment round to build more manufacturing space and grow its sales force globally and in the United States to pitch products and secure new customers.

In 2015, NanoMech created a separate trucking division to develop a series of Nano™ line products, specially designed to provide a vastly improved level of performance-increasing resistance to electrical malfunction, corrosion, and oxidation in heavy-duty trucks and to meet the niche requirements of the trucking industry. Since then, the company has partnered with industry majors such as JB Hunt, Crete, and SAIA which appreciates the lubrication products and anti-corrosion coatings developed by NanoMech. With the development of truck and tractor chassis lubrication, the NanoMech solutions provide extreme pressure protection, the longest-water resistance, maximum operating temperature tolerances, and enhanced corrosion resistance allowing for a significant increase in uptime and decrease in overall cost and labor. The company has also engaged with sustainability drivers, such as Tesla, for automotive coatings and lubrication applications for new Electric Vehicle (EV) models, such as the Model S and Model X cars.

NanoMech welcomes constant interaction and feedback on products and improvises to meet customer's exact specifications and needs. Based on proven performance and NanoMech's existing customer recommendations, robust and strategic partnerships have been established with industry leading OEMs, such as Daimler and Navistar, who are some of the largest truck manufacturers in the world".

Frost & Sullivan is impressed with the high level of client satisfaction that NanoMech enables by ensuring specialized and dedicated R&D, manufacturing, and customer service teams that provide world-class capabilities.

Conclusion

NanoMech has gained extensive, unique expertise in the development of state-of-the-art materials and components in nanotechnology through its intensive R&D capabilities, an outstanding management and science team, partnerships, and joint ventures with government agencies and private sector majors. As a result, the company has gained a strategic position as a key player in the industry.

NanoMech is continually engaged in extensive research for the development of high-performing and cost-effective nanotechnology-based coatings and lubrication solutions. Frost & Sullivan commends the company's well-structured approach of identifying and overcoming functional and cost challenges in manufacturing, transportation, military, oil and gas, aerospace, and other industries by developing next-generation nanotechnology-based solutions. Its tremendous advances serve as a benchmark for future research and new product development.

Frost & Sullivan applauds NanoMech's R&D efforts towards developing nanotechnology-based solutions that tremendously enhance the performance of equipment, machines, and devices, and for its strong overall performance in nanotechnology innovation, NanoMech Inc. has earned Frost & Sullivan's 2018 Technology Innovation Award.

Significance of Technology Innovation

Ultimately, growth in any organization depends upon finding new ways to excite the market and upon maintaining a long-term commitment to innovation. At its core, technology innovation, or any other type of innovation, can only be sustained with leadership in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.

Understanding Technology Innovation

Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole.

Key Benchmarking Criteria

For the Technology Innovation Award, Frost & Sullivan analysts independently evaluated two key factors—Technology Attributes and Future Business Value—according to the criteria identified below. Technology Attributes

Criterion 1: Industry Impact
Criterion 2: Product Impact
Criterion 3: Scalability
Criterion 4: Visionary Innovation
Criterion 5: Application Diversity

Future Business Value

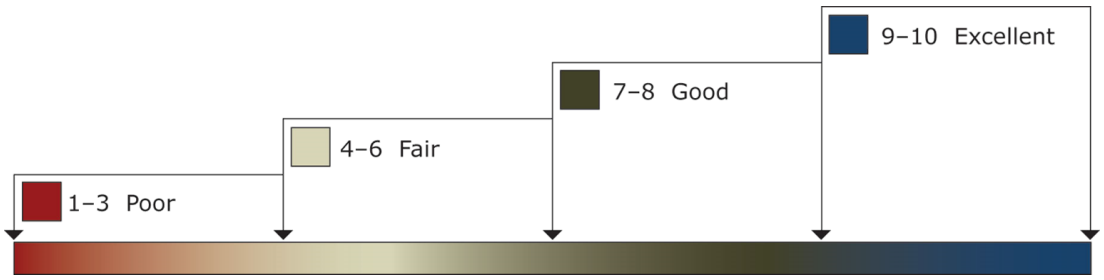
Criterion 1: Financial Performance
Criterion 2: Customer Acquisition
Criterion 3: Technology Licensing
Criterion 4: Brand Loyalty
Criterion 5: Human Capital

Best Practices Award Analysis for NanoMech Inc.

Decision Support Scorecard

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Scorecard. This tool allows our research and consulting teams to objectively analyze performance, according to the key benchmarking criteria listed in the previous section, and to assign ratings on that basis. The tool follows a 10-point scale that allows for nuances in performance evaluation. Ratings guidelines are illustrated below.

RATINGS GUIDELINES



The Decision Support Scorecard is organized by Technology Attributes and Future Business Value (i.e., These are the overarching categories for all 10 benchmarking criteria; the definitions for each criterion are provided beneath the scorecard.). The research team confirms the veracity of this weighted scorecard through sensitivity analysis, which confirms that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, we have chosen to refer to the other key participants as Competitor 2 and Competitor 3.

Measurement of 1–10 (1 = poor; 10 = excellent)			
Technology Innovation	Technology Attributes	Future Business Value	**Average Rating**
NanoMech Inc.	**9**	**9**	**9**
Competitor 2	8	7.5	7.75
Competitor 3	7.5	7.5	7.5

Technology Attributes

Criterion 1: Industry Impact

Requirement: Technology enables the pursuit of groundbreaking ideas, contributing to the betterment of the entire industry.

Criterion 2: Product Impact

Requirement: Specific technology helps enhance features and functionalities of the entire product line for the company.

Criterion 3: Scalability

Requirement: Technology is scalable, enabling new generations of products over time, with increasing levels of quality and functionality.

Criterion 4: Visionary Innovation

Requirement: Specific new technology represents true innovation based on a deep understanding of future needs and applications.

Criterion 5: Application Diversity

Requirement: New technology serves multiple products, multiple applications, and multiple user environments.

Future Business Value

Criterion 1: Financial Performance

Requirement: Potential is high for strong financial performance in terms of revenues, operating margins, and other relevant financial metrics.

Criterion 2: Customer Acquisition

Requirement: Specific technology enables acquisition of new customers, even as it enhances value to current customers.

Criterion 3: Technology Licensing

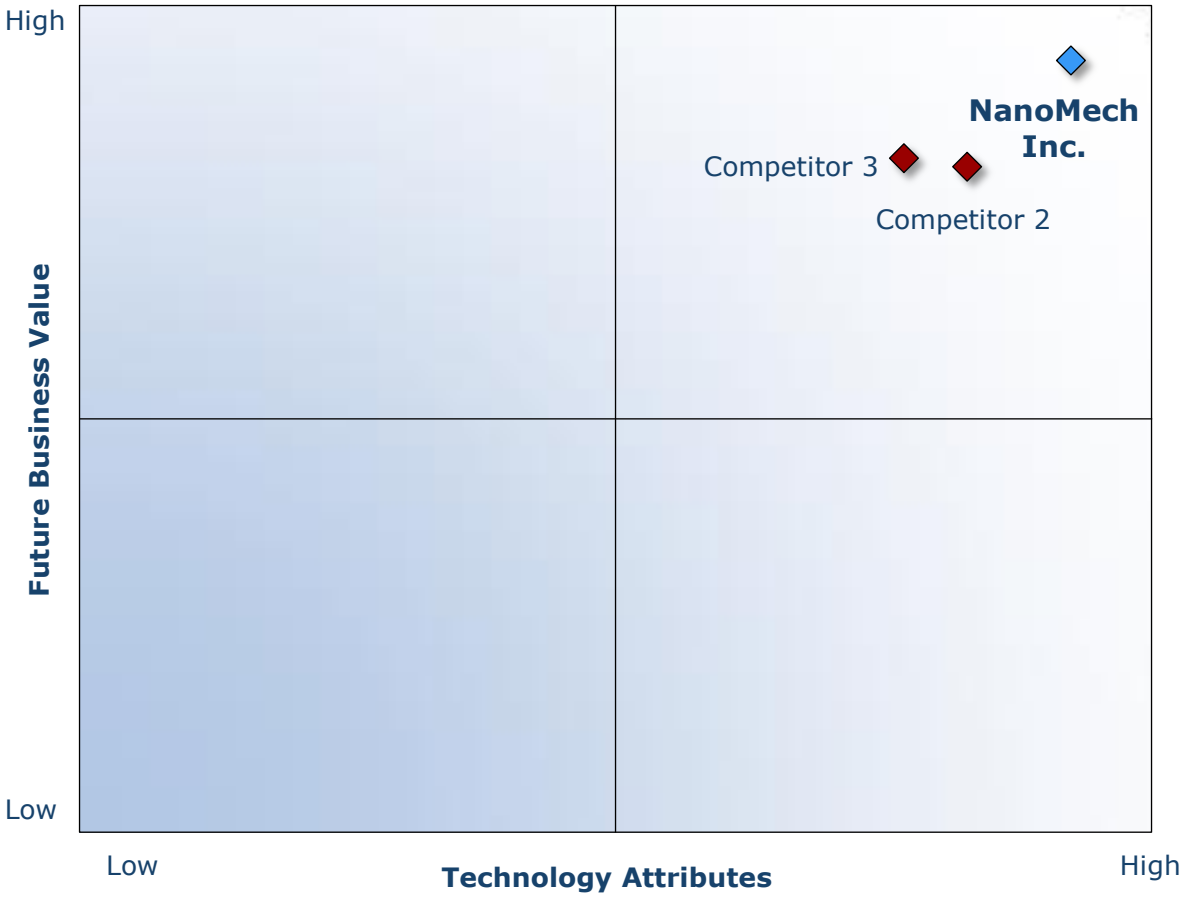
Requirement: New technology displays great potential to be licensed across many sectors and applications, thereby driving incremental revenue streams.

Criterion 4: Brand Loyalty
Requirement: New technology enhances the company's brand, creating and/or nurturing brand loyalty.

Criterion 5: Human Capital
Requirement: Customer impact is enhanced through the leverage of specific technology, translating into positive impact on employee morale and retention.

Decision Support Matrix

Once all companies have been evaluated according to the Decision Support Scorecard, analysts then position the candidates on the matrix shown below, enabling them to visualize which companies are truly breakthrough and which ones are not yet operating at best-in-class levels.



Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analyst follow a 10-step process to evaluate Award candidates and assess their fit with select best practice criteria. The reputation and integrity of the Awards are based on close adherence to this process.

	STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1	**Monitor, target, and screen**	Identify Award recipient candidates from around the globe	• Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies	Pipeline of candidates who potentially meet all best-practice criteria
2	**Perform 360-degree research**	Perform comprehensive, 360-degree research on all candidates in the pipeline	• Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates	Matrix positioning of all candidates' performance relative to one another
3	**Invite thought leadership in best practices**	Perform in-depth examination of all candidates	• Confirm best-practice criteria • Examine eligibility of all candidates • Identify any information gaps	Detailed profiles of all ranked candidates
4	**Initiate research director review**	Conduct an unbiased evaluation of all candidate profiles	• Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles	Final prioritization of all eligible candidates and companion best-practice positioning paper
5	**Assemble panel of industry experts**	Present findings to an expert panel of industry thought leaders	• Share findings • Strengthen cases for candidate eligibility • Prioritize candidates	Refined list of prioritized Award candidates
6	**Conduct global industry review**	Build consensus on Award candidates' eligibility	• Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates	Final list of eligible Award candidates, representing success stories worldwide
7	**Perform quality check**	Develop official Award consideration materials	• Perform final performance benchmarking activities • Write nominations • Perform quality review	High-quality, accurate, and creative presentation of nominees' successes
8	**Reconnect with panel of industry experts**	Finalize the selection of the best-practice Award recipient	• Review analysis with panel • Build consensus • Select recipient	Decision on which company performs best against all best-practice criteria
9	**Communicate recognition**	Inform Award recipient of Award recognition	• Announce Award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance	Announcement of Award and plan for how recipient can use the Award to enhance the brand
10	**Take strategic action**	Upon licensing, company is able to share Award news with stakeholders and customers	• Coordinate media outreach • Design a marketing plan • Assess Award's role in future strategic planning	Widespread awareness of recipient's Award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of our research process. It offers a 360-degree-view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS

About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages more than 50 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit http://www.frost.com.