Nanofilm Technologies International Limited
Recognized for

2021

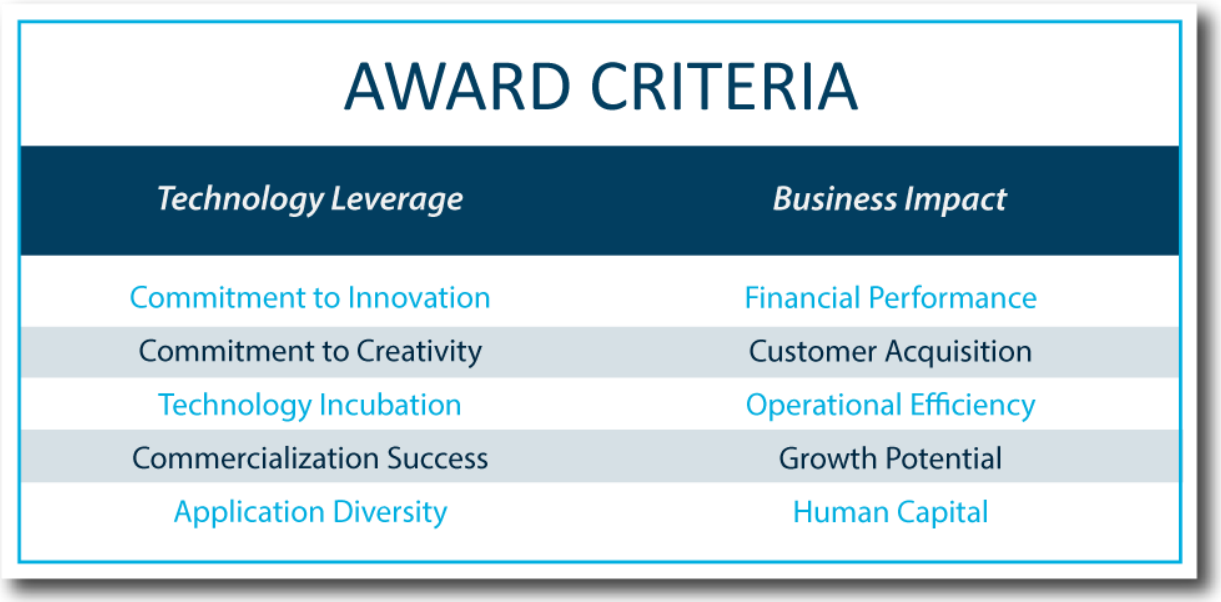
Technology Innovation Leadership

Asia-Pacific
Nanocoating Deposition Industry
Excellence in Best Practices

FROST & SULLIVAN

Best Practices Criteria for World-Class Performance

Frost & Sullivan applies a rigorous analytical process to evaluate multiple nominees for each award category before determining the final award recipient. The process involves a detailed evaluation of best practices criteria across two dimensions for each nominated company. NTI excels in many of the criteria in the nanocoating deposition technology space.



A Unique and Advanced Nanofilm Deposition Technology Enables Unprecedented Commercialization Success

The study and manipulation of materials at atomic, molecular, and macromolecular scale is a critical, costly, and time-consuming task. One example is nanofilm deposition, which implies applying a nanometer-thin film of material (nanoscale) to coat a substrate to form layers.[1] This deposition process is crucial for modern industries such as semiconductors, solar panels, nanoelectronics, and optical devices. There are numerous ways to execute nanofilm deposition. Chemical vapor deposition (CVD) and physical vapor deposition (PVD) are traditional and the most popular deposition techniques to produce thin films and coatings. CVD comprises a vacuum chamber, where chemical precursors are heated, allowing them to vaporize and meet on the substrate's surface to start a chemical reaction that forms a thin film coating. PVD involves multiple deposition techniques such as evaporation, magnetron sputtering, and ion beam sputtering, among others, to create high-quality coatings. Although popular, these techniques fall short of traditional high waste deposition and high heating temperature standards. These shortcomings can result in non-uniform coatings and reduced material strength. Companies can mitigate these inadequacies by using high-cost cooling systems and highly skilled operators, which drastically increases the overall system cost.

[1] http://www.semicore.com/news/81-what-is-thin-film-deposition

To achieve highly uniform thin film coatings with better adhesion characteristics at a significantly lower substrate temperature, Nanofilm Technologies International Limited (NTI) developed a revolutionary filtered cathodic vacuum arc (FCVA) technology that leverages a plasma source and electromagnetic waves to create high-quality coatings. Founded in 1999 as a high-tech spinoff from Nanyang Technological University, NTI's robust in-house engineering capabilities have allowed it to create new design opportunities across many industries such as computer, communication and consumer electronics (3C), automotive, precision engineering, and printing and imaging. The company's innovative FCVA technology can perform approximately five microns vacuum coating deposition at room temperature, allowing it to coat on a broad range of substrate materials, such as plastics, rubber, and ceramics, which was previously undoable using traditional coating technologies. With a strong research and development (R&D) capability and expertise, the company also combines its proprietary FCVA technology with conventional PVD-based sputtering method (FCVA-hybrid with PVD) to offer functional surface solutions, thereby enabling cost-effectiveness and environment-friendliness. The FCVA / FCVA-hybrid technology also enables best-in-class technical specifications such as very low coating pressure of 1E-3Pa (compared to a pressure of 5E-1Pa through PVD) and very high density of approximately 3.4 gram per cubic centimeter (g/cm^3) (compared to a film density of 2.2 g/cm^3 using PVD), thereby ensuring enhanced durability and increased end-product lifespan. By leveraging this exceptional hybrid combination, NTI develops top-notch proprietary advanced materials such as:

> *"NTI's FCVA technology has opened new avenues for quicker, high-quality, and cost-effective nanofilm coatings. Its advanced materials seamlessly enhance the average useful life of customers' end-products, thereby enabling the company to expand and proliferate in new market segments and industries."*
>
> ***- Rabin Dhakal, Best Practices Research Analyst***

- **TAC-ON®:** This advanced material utilizes tetrahedral amorphous carbon with a diamond structure containing up to 88% diamond content, having properties such as high hardness, high adhesion, low friction coefficient, low deposition temperature, and high density.
- **iTAC®:** It is a derivative of TAC-ON® and is utilized in surface solutions for automotive piston rings, extending its average life expectancy by more than five times compared to other diamond materials.
- **MiCC®:** A nano-crystalline chrome-nitride ceramic advanced material that possesses the ability to deposit on substrates at low temperature, thereby providing superior adhesion, high surface hardness, and low friction co-efficient.

Frost & Sullivan believes that the coatings achieved through NTI's highly advanced FCVA technology yield superior results, surpassing the highest benchmarks and exhibiting extraordinary performance.

Furthermore, NTI's incredible commercialization success is the direct result of robust market strategies in mission-critical applications for multiple industries and is contributed by few key factors such as its proprietary technology, quality of nanotechnology solutions, customer service, cost-effectiveness, and high value-addition capability. The company possesses more than 75 patents and is continually dedicated to create patent innovations through research, development, dissemination, and market development. With more than 300 customers across various market segments, the company proliferates and captures new and emerging industries, including biomedical, internet of things, aerospace, electric vehicle, and optics, among others. The company primarily offers best-in-class services across three business units, viz advanced materials, nanofabrication, and industrial equipment. For instance, under the nanofabrication business unit, the company designs customized optical sensory nanoproducts to fit customers' specific size and requirements with critical properties such as anti-reflection, anti-glare, and far-field and near-field infrared performance. These innovations have allowed NTI to expand its addressable market, especially in sectors such as optical lens and sensory components, 3C, and automotive markets.

Frost & Sullivan applauds NTI for its exemplary R&D and technology leverage that allowed the company to develop an advanced nanofilm deposition technology, enabling it to provide innovative offerings and drive sustainable growth.

A Robust Customer-focused Strategy Results in Top-notch Financial Performance

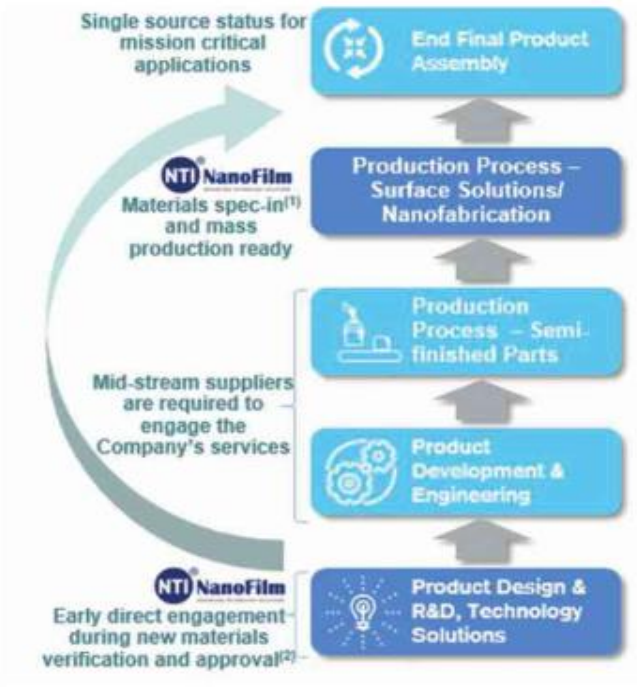
By combining highly advanced nanotechnology solutions and an early direct engagement with customers, NTI provides a strong value chain network to ensure consistency and quality. This strategy allows the company to proliferate across multiple industries and market segments. Moreover, despite the COVID-19 pandemic, NTI reached an outstanding revenue of $77.8 million in the first half of 2020, which is an increase of $22.6 million from the same period in 2019.[2] Its business units' contribution in the total revenue are 82.4%, 4.1%, and 13.5%, respectively, from advanced materials, nanofabrication, and industrial equipment unit.

NTI focuses on strong relationship-building by engaging with customers from an early product development and design stage to provide value-added services to customers and enable seamless customer acquisition and stickiness. Specifically, the company continually engages with customers to design and develop proprietary materials to coat into their end-products to achieve desired functional and aesthetic properties. The company taps into the pain points of various end-products to understand the requirements and develop materials to propose a cost-friendly, high-quality solution and extends the end-products' useful life. For instance, NTI found that the materials for piston rings designed and developed using conventional coating technologies could exhibit high wear and tear, causing greater emission and accounting for high total engine friction loss. With its highly advanced coating technology, the company could extend the useful life of piston rings by more than five times, allowing lower emissions and energy loss and enabling automotive component manufacturers to meet the latest Euro VI emission standard conveniently. NTI's proprietary technologies have solved various industry and end-

[2] https://links.sgx.com/FileOpen/Nanofilm%20Technologies%20International%20Limited%20-%20Prospectus%20(23%20Oct%202020).ashx?App=IPO&FileID=6228

product-specific problems and bottlenecks, allowing the company to capture a large share of its markets and expand to new markets.

NTI's customer-centric co-development model



Source: NTI prospectus

Likewise, NTI exhibits enormous potential in newly established end-market segments. For instance, in the fast-moving consumer goods personal grooming industry, the company's FCVA technology can deposit its advanced materials on zinc substrates, making it a sustainable and commercially viable alternative to chrome plating. Also, the bi-polar plate electrodes in the fuel cells of electric vehicles require a surface solution that provides high electrical conductivity and high corrosion resistance. Currently, the gold plating solution utilized in the market is costly and does not exhibit high corrosion resistance.

> *"By implementing a customer-centric co-development strategy, NTI ensures early customer engagement, enabling it to maintain high customer stickiness. Its superior technology leverage allows the company to deliver top-notch alternatives to existing nanofilm deposition techniques while providing additional first-class enhancements and properties."*
>
> ***- Rabin Dhakal, Best Practices Research Analyst***

NTI's advanced materials-based surface solution provides a cost-effective alternative to gold plating while providing highly advanced functional properties such as high corrosion resistance and high conductivity. The company also leverages its proprietary FCVA technology to enhance conventional materials, such as copper and aluminum with improved nanoproperties, allowing it to be used for various applications such as a plastic antenna for fifth-generation networks for high-frequency transmission. NTI has its R&D facilities and research centers in Singapore, Shanghai, and Osaka, containing state-of-the-art machines and technologies. With four production facilities across China,

Vietnam, and Singapore, the company holds an impressive production capacity of seven million nanofilm-coated parts per day. By leveraging its industry-agnostic technological capabilities and top-notch R&D innovation and product development abilities, NTI demonstrates strong growth potential in existing and newer markets.

Frost & Sullivan praises NTI for its ability to witness the superior financial performance and high customer stickiness since its establishment by developing a strong technological foundation and robust in-house engineering capability.

Conclusion

Conventional nanofilm deposition techniques, such as chemical vapor deposition and physical vapor deposition, require high heat to perform coatings, which can sometimes result in non-uniform coatings and high waste deposition. These methods are expensive and do not guarantee high-quality coatings. Nanofilm Technologies International Limited (NTI) is a leading player in the nanofilm deposition technology space and leverages a plasma source and electromagnetic waves to achieve high-quality coatings. NTI's proprietary technology for nanofilm deposition called the filtered cathodic vacuum arc (FCVA) does not require high heat and can perform vacuum coating deposition at room temperature. This exceptional feature allows the company to create advanced materials with high density, high corrosion resistance, high conductivity, and low friction co-efficient. By leveraging its FCVA technology and developing a rigorous customer engagement culture, NTI has witnessed a top-notch customer acquisition rate over the years.

For its innovative ability, exceptional research and development focus, and robust customer engagement culture, NTI earns Frost & Sullivan's 2021 APAC Technology Innovation Leadership Award in the nanocoating deposition technology market.

What You Need to Know about the Technology Innovation Leadership Recognition

Frost & Sullivan's Technology Innovation Award recognizes the company that has introduced the best underlying technology for achieving remarkable product and customer success while driving future business value.

Best Practices Award Analysis

For the Technology Innovation Leadership Award, Frost & Sullivan analysts independently evaluated the criteria listed below.

Technology Leverage

Commitment to Innovation: Continuous emerging technology adoption and creation enables new product development and enhances product performance

Commitment to Creativity: Company leverages technology advancements to push the limits of form and function in the pursuit of white space innovation

Stage Gate Efficiency: Technology adoption enhances the stage gate process for launching new products and solutions

Commercialization Success: Company displays a proven track record of taking new technologies to market with a high success rate

Application Diversity: Company develops and/or integrates technology that serves multiple applications and multiple environments

Business Impact

Financial Performance: Strong overall financial performance is achieved in terms of revenues, revenue growth, operating margin, and other key financial metrics

Customer Acquisition: Customer-facing processes support efficient and consistent new customer acquisition while enhancing customer retention

Operational Efficiency: Company staff performs assigned tasks productively, quickly, and to a high-quality standard

Growth Potential: Growth is fostered by a strong customer focus that strengthens the brand and reinforces customer loyalty

Human Capital: Commitment to quality and to customers characterize the company culture, which in turn enhances employee morale and retention

About Frost & Sullivan

Frost & Sullivan is the Growth Pipeline Company™. We power our clients to a future shaped by growth. Our Growth Pipeline as a Service™ provides the CEO and the CEO's growth team with a continuous and rigorous platform of growth opportunities, ensuring long-term success. To achieve positive outcomes, our team leverages over 60 years of experience, coaching organizations of all types and sizes across 6 continents with our proven best practices. To power your Growth Pipeline future, visit Frost & Sullivan at http://www.frost.com.

The Growth Pipeline Engine™

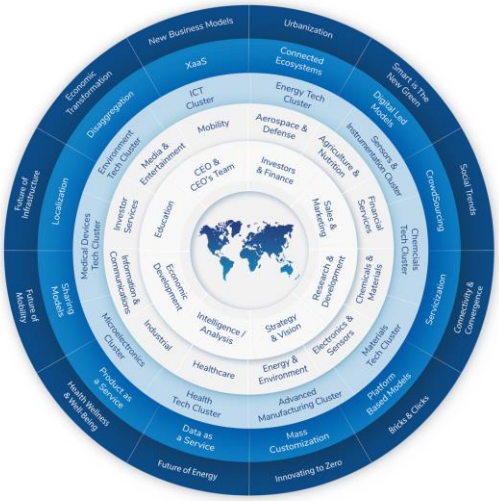
Frost & Sullivan's proprietary model to systematically create on-going growth opportunities and strategies for our clients is fuelled by the Innovation Generator™. Learn more.

Key Impacts:

- **Growth Pipeline:** *Continuous flow of Growth opportunities*
- **Growth Strategies:** *Proven Best Practices*
- **Innovation Culture:** *Optimized Customer Experience*
- **ROI & Margin:** *Implementation Excellence*
- **Transformational Growth:** *Industry Leadership*

The Innovation Generator™

Our six analytical perspectives are crucial in capturing the broadest range of innovative growth opportunities, most of which occur at the points of these perspectives.



Analytical Perspectives:

- Mega Trend (MT)
- Business Model (BM)
- Technology (TE)
- Industries (IN)
- Customer (CU)
- Geographies (GE)