TactoTek Recognized for

2021

New Product Innovation

European Structural
Electronics 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. TactoTek excels in many of the criteria in the structural electronics space.

Match to Needs

Industrial manufacturers of products ranging from automobiles to lighting incorporate electronics to provide greater functionalities to their products. These manufacturers must facilitate the integration of delicate electronic components into environments subject to dust, moisture, shock, temperature swings, and vibration. The typical solution is to encase electronics in plastic, often a complex process requiring multi-part plastic housings and mounting arrangements. These plastic forms must conform to the often complex shapes of the electronics they protect, fit the space within the larger product, and exhibit the required aesthetic appearance of the finished product.

> *"TactoTek announced in January 2021 that its IMSE® solutions reduce material and energy use relative to conventional electronics. Both traits are essential since the European Union and Is enacting stricter regulations for improved industrial resources usage. Specifically, in an independent cradle to gate lifecycle analysis comparing an IMSE® part with a conventional electronics equivalent, IMSE® reduced plastics use by 70% and lowered greenhouse gas emissions by 35%."*
>
> ***- Michael Valenti, Senior Consultant***

TactoTek Oy (TactoTek®) of Oulunsalo, Finland, addresses these challenges with its In-Mold Structural Electronics solutions, known collectively as IMSE®. These solutions encapsulate and integrate standard electronic components and printed electronics within 3D injected molded plastics to make smart molded structures. IMSE® parts are as durable as the plastic resins that are used to make them,

such as polycarbonate, TPU, and others, and can conform to complex shapes. TactoTek® works directly with its clients to ensure that its IMSE® solutions meet specific electrical performance, structural, and visual quality requirements.

TactoTek® announced in January 2021 that its IMSE® solutions reduce material and energy use relative to conventional electronics. Both traits are essential because the European Union is enacting stricter regulations for improved industrial resource usage. Specifically, in an independent cradle to gate lifecycle analysis comparing an IMSE® part with a conventional electronics equivalent, IMSE® reduces plastics use by 70% and lowers greenhouse gas emissions by 35%. The cumulative effect of reducing the amount of materials, mass and volume of parts also plays a big role in reducing the environmental impact of up- and downstream logistics. TactoTek® extensively uses simulation processes to reduce the number of prototypes required to have an IMSE® part ready for serial production. Because IMSE® parts combine cosmetic, structure, and electronic functions in one seamless, single piece part, it reduces the number of manufacturing tools needed relative to conventional electronics fabrication up to 90%. Making IMSE® parts uses clean additive processes and generates minimal waste streams. These attributes make IMSE® structural electronics technology a greener solution than conventional electronics.

Positioning

TactoTek® IMSE® structures are thin, typically 2mm-4mm wall thickness, and can conform to complex shapes and, thus, can deliver electronic functionality in locations difficult or prohibitive for conventional electronics.

The IMSE® manufacturing process relies on standard, high speed equipment available globally. Making an IMSE® part begins with the printing electronics, including antennas, conductive circuitry, proximity sensors, and touch controls on a plastic film. The second step is surface mounting electronic components with standard high speed, two-dimensional pick-and-place equipment. Components are secured with conductive and structural adhesives.

In the next step, high pressure forming, the flat plastic film that includes electronics takes on its three-dimensional shape. The formed film is then inserted into an injection mold and all electronics are encapsulated in standard high temperature, high pressure plastic molding. The result is a seamless single-piece encapsulated structure made of polycarbonate, thermoplastic polyurethane, or other rugged polymers suitable for automotive, appliance, aerospace, medical, smart home and IoT use cases.

In conventional electronics, cosmetic surfaces and light management components are typically separate elements of an assembly, by combining those functions into a single 2mm-4mm part, IMSE® can reduce assembly depth by up to 90%, making it easier to fit the encapsulated parts into tight spaces. This also translates into a weight reduction of up to 70%, an important consideration in reducing automobile fuel consumption.

Reliability

TactoTek® dedicates substantial effort to ensure that all the inputs to IMSE® parts are compatible for high yield manufacturing and a lifetime of reliability. This is challenging given the material variety used in IMSE® solutions that can include silver-based functional inks, decorative inks, dielectric materials to insulate multilayer circuitry, conductive and structural adhesives to attach electronic components physically to the material substrate, plastic films, and injection molding resin.

When these different materials are all put through the IMSE® manufacturing process, they are subject to high temperatures during thermoforming and injection molding, the latter including high pressure. Heat and pressure act as catalysts that electronics manufacturers must consider when making a finished encapsulated part.

> *"TactoTek® invests a large part of its organization in this internal process called the T process. The team captures test data and uses it to perform small-scale production at TactoTek's production facility and confirms results. Thus, TactoTek builds reliability into its IMSE® parts by following the design rules for the material stacks it validates."*
>
> ***- Michael Valenti. Senior Consultant***

TactoTek® employs a team dedicated to evaluating the material properties of any and every IMSE® part input – film, functional ink, dielectric material, adhesives, and electronic components – and assessing them. The team first performs paper studies, then proceeds to test materials first individually and then in combination by making IMSE® parts and then tests the entire material stack to determine if it performs well when exposed to stringent automotive and industrial/electrical requirements. An example is the minus 40 to plus 85 degrees Celsius temperature range thermal shock, and 85C/85%RH damp heat test and 110 degrees high temperature aging for 1,000 hours required by automotive. IMSE® parts are also tested for resistance to vibration, which is less critical because in the finished IMSE® part components are encapsulated in plastic in a single piece structure. As such, they cannot move in relation to one another due to vibration.

The analytical team captures the test data and uses it to perform small-scale production at TactoTek®'s production facility to verify materials performance and related design rules. Parts from the small scale production are used for reliability tests. Data from the production batch and reliability testing is evaluated to verify materials/components compatibility for IMSE manufacturing and lifetime performance requirements and design rules are added to TactoTek®'s library. Thus, TactoTek® builds reliability into its IMSE® parts by following the design rules for the material stacks it validates.

The Finnish company's primary business is licensing IMSE® technology, and it works with OEMs directly to find the best use cases. Licensees mass-produce IMSE® products. These enterprises include automotive suppliers such as Faurecia SE of France, Kyocera Corporation of Japan, LS Automotive technologies of South Korea, and Techniplas.

Price/Performance Value

Standard electronics continue to use the multilayer design of earlier years when components were contained in wooden or metal boxes. These are now held in plastic boxes, influencing the design concept. TactoTek® can design to the strengths and capabilities of printed electronics by using them for

its IMSE® solutions. A single-piece construction reduces the number of suppliers, tooling, and inventorying of multiple parts, improving economics significantly. In many cases, manufacturers can avoid the high costs they would incur using standard electronic components housed in multi-part plastic housings.

As its name implies, IMSE® creates electronic structures that can integrate standards-based electronics into the complex shapes of a vehicle cockpit or a coffee pot that its competitors cannot do. A good example is illumination crafted to become part of a premium vehicle's decorative styling.

Customer Service Experience

TactoTek® works closely with customers – OEMs and brands at one level and IMSE® licensees on another – to make its service as accessible, fast, and as stress-free as possible. This enables customers to understand and envision uses for the IMSE® solutions. The Finnish company employs project managers and engineers for each discipline involved in getting an IMSE® part from concept to mass production-ready. The service staff includes electrical and illumination engineers, system electronics and tooling designers, and injection molding and antenna experts.

When TactoTek® engages with an OEM via an account lead, the Finnish company educates the OEM on IMSE® and accommodates them with these solutions. It typically fabricates proof-of-concept parts faster than any of its competitors because it has in-house production that includes each of the manufacturing steps to engineer and manufacture IMSE® parts and know-how, developed over years of learning what works in in-mold structural engineering of electronic components.

When a customer licenses TactoTek® technology, the latter provides documents and digital curriculum to clients to train their employees. A key differentiator is that TactoTek® also brings the customer's engineers and designers into its own facility to support hands-on technology transfer. Since the COVID-19 lockdowns, it has conducted these as classroom sessions via live video conferencing, but in-person visits to the TactoTek® facility have returned recently.

TactoTek® built a standardized injection molding test platform that it uses, for example, for IMSE® production at a licensee's facility, to confirm successful technology transfer. If desired, the company visits its licensee's site to work with their team to tune the IMSE® production process.

Customer Purchase Experience

Customer testimonials show that IMSE® solutions provide the optimal solution for their unique needs and constraints. PassiveBolt Inc. of Ann Arbor, Michigan, specializes in developing smart access devices, including the Shepherd Lock, which uses touch and facial recognition to permit keyless entry.

A critical Shepherd Lock component is its smart cover that combines electronic circuitry, contact pads for external connectivity, and light-emitting diodes for illuminating lock status in a single structure that is also aesthetically pleasing. TactoTek® used its IMSE® technology to achieve all these goals. PassiveBolt reported working closely with TactoTek® engineers to execute the former's design using IMSE® technology and declared it is pleased by the result, which won the CES 2020 Innovation Award presented by the Consumer Technology Association.

The Phiaro Corporation of Saitama, Japan, announced in January 2021 that it would integrate

TactoTek®'s IMSE™ technology into its automotive solutions, found in concept vehicles, racing cars, and mass-produced consumer vehicles from major OEMs. The Japanese company's president described Phiaro's mission to translate design, engineering, and advanced technologies into autonomous operation, electric power, and low-impact personal urban mobility. The executive noted that TactoTek®'s IMSE® would support wireless connectivity, integrated illumination, attractive aesthetics, and the seamless user interface demanded by Phiaro's customers.

Conclusion

Industrial manufacturers continue to put electronics into their products to add functions for greater utility, to automate functions to ease their use, and to enhance aesthetics. Automotive and other industrial applications will subject those electronics to dirt, moisture, and thermal cycles that can harm them, requiring effective protection. The complexity of protecting electronic components in harsh conditions adds considerably to their cost and can be a design challenge due to added bulk and weight. TactoTek® addresses these challenges with its IMSE® technology, which effectively converts individual thin films, adhesives, and electronic parts into a single part that is lightweight, durable, and delivers reduced total cost of ownership while providing engineers greater design freedom. The company recently demonstrated the reduced environmental impact of its IMSE® structures. This strong performance earns TactoTek Oy Frost & Sullivan's 2021 European New Product Innovation Award in structural electronics.

What You Need to Know about the New Product Innovation Recognition

Frost & Sullivan's New Product Innovation Award recognizes the company that offers a new product or solution that uniquely addresses key customer challenges.

Best Practices Award Analysis

For the New Product Innovation Award, Frost & Sullivan analysts independently evaluated the criteria listed below.

New Product Attributes

Match to Needs: Customer needs directly influence and inspire product design and positioning

Reliability: Product consistently meets or exceeds customer performance expectations

Quality: Product offers best-in-class quality with a full complement of features and functionality

Positioning: Product serves a unique, unmet need that competitors cannot easily replicate

Design: Product features an innovative design that enhances both visual appeal and ease of use

Customer Impact

Price/Performance Value: Products or services provide the best value for the price compared to similar market offerings

Customer Purchase Experience: Quality of the purchase experience assures customers that they are buying the optimal solution for addressing their unique needs and constraints

Customer Ownership Experience: Customers proudly own the company's product or service and have a positive experience throughout the life of the product or service

Customer Service Experience: Customer service is accessible, fast, stress-free, and high quality

Brand Equity: Customers perceive the brand positively and exhibit high brand loyalty

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 six continents with our proven best practices. To power your Growth Pipeline future, visit Frost & Sullivan at http://www.frost.com.

The Growth Pipeline Engine™

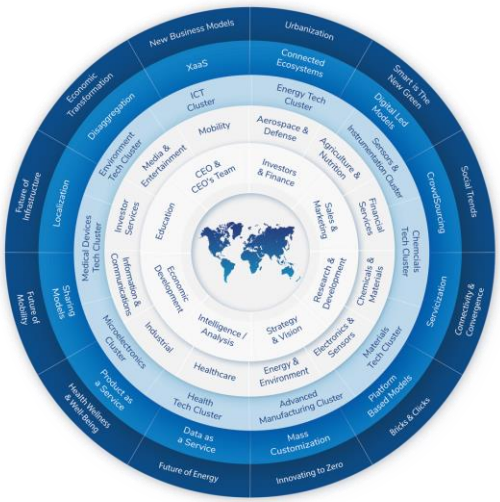
Frost & Sullivan's proprietary model to systematically create ongoing growth opportunities and strategies for our clients is fuelled by the Innovation Generator™.
Learn more.

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)