BATENE GMBH

ADVANCED 3D METAL FIBER NETWORKS FOR NEXT-GENERATION ENERGY STORAGE

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Company Overview & Vision

Batene GmbH is an early-stage **Max Planck Institute spin-off (founded March 2022)** developing cutting-edge composite and three-dimensional (3D) metal fiber network technologies for energy storage and beyond. The company's mission is to **revolutionize battery performance** – enabling **thicker, faster-charging, safer, and more cost-effective batteries** – to accelerate the transition to a sustainable, electrified economy. Batene's core innovation, the **batene fleece™**, replaces traditional 2D metal foils in battery cells with a porous metal fiber "fleece" current collector, dramatically improving cell capacity and power while reducing materials and weight. Batene holds **patent-pending IP** (licensed exclusively from the Max Planck Society) on these advanced metal fiber network structures (e.g. *EP4605236A1*, *WO2024100261A1*, *WO2024100262A1*), positioning the company at the forefront of battery materials innovation.

Breakthrough Technology: Composite 3D Metal Fiber Networks

Batene's technology is based on **ultra-fine metal fibers** (down to single-digit micron diameters) that are formed into a 3D conductive network (a nonwoven "fleece") and integrated with a conductive support layer. This creates a **composite metal network structure** – essentially a 3D metal fiber current collector *sintered* onto a metallic foil or mesh backing. This design offers **unique advantages** over conventional flat foil electrodes:

- **3D Electron Pathways:** The fiber network provides a web of conductive paths throughout the electrode thickness, while the support layer conducts across the plane. This dual-layer approach distributes current in three dimensions, eliminating the bottlenecks and voltage drops seen in thick conventional electrodes.
- **Mechanical Reinforcement:** The bonded support layer mechanically stabilizes the delicate fiber mesh. It prevents fiber breakage or compression during manufacturing and cycling, addressing the fragility of standalone metal foams. The result is a robust electrode structure that tolerates handling and repeated charging without degradation.

- **Scalable, Roll-to-Roll Production:** Batene's composite fleece can be produced in continuous sheets compatible with standard roll-to-roll processing. The sintered layer design is engineered as a **"drop-in" solution for existing battery production lines** – manufacturers can swap 2D foils for Batene's 3D fleece with minimal process changes. This greatly eases adoption and scalability in high-volume cell factories.

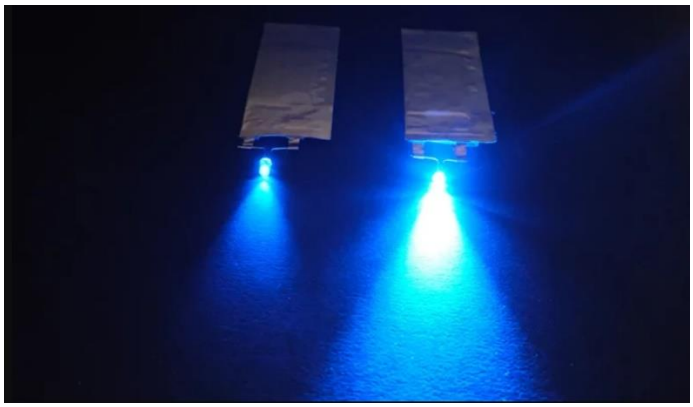
Notably, Batene's recent patent filings describe methods to manufacture these fiber networks and composite structures at scale, including processes for sintering fibers onto metal substrates and filling the network with active material. The **proprietary process** (pioneered by Prof. Joachim Spatz's team at the Max Planck Institute for Medical Research) produces **fine metallic fibers and meshes** with controlled size and surface properties. One invention even features metal fibers with **anisotropic surface texture** (smooth at one end, textured at the other) to optimize bonding and electrical contact in the network. These technical innovations give Batene a defensible IP position in next-gen current collectors.

Key Benefits & Differentiators

Batene's composite 3D metal fiber network unlocks a **step-change in battery cell performance**. Key advantages include:

- **Higher Energy Density (Thicker Electrodes):** Batene enables **millimeter-thick electrodes** (up to 2–3 mm vs ~0.2 mm today) packed with >90% active material by weight. By cutting inactive foil mass to a tenth, the design **increases energy storage per cell by up to 80%**. In practical terms, batteries can store much more energy without increasing size, directly translating to longer EV driving range and device runtimes.
- **Faster Charging & High Power:** The 3D fiber mesh offers **huge surface area and continuous conductive pathways**, dramatically reducing internal resistance. Electrons and ions can move freely through the porous scaffold, enabling **extreme fast charging and high discharge currents** without overheating. For instance, the metal fleece cells charge and deliver current so efficiently that they can be discharged at high rates **with minimal voltage drop**. **Lab prototypes have shown ~50% higher capacity** (under constant current) and more uniform charge distribution compared to standard electrodes, demonstrating the potential for **greater power output and throughput**.

- **Enhanced Safety & Stability:** With the fiber network carrying current uniformly, **hotspots and current crowding are eliminated**, lowering heat generation and risk of thermal runaway. The fleece structure is also highly elastic and **accommodates electrode expansion** (e.g. silicon or lithium metal swelling) without cracking. This mitigates stress and **prevents premature aging or dendrite formation**, vastly improving cycle life and safety. Batteries using Batene's reinforced electrodes maintain stable capacity over many cycles, whereas conventional cells rapidly degrade when pushed to high thickness or fast charge.
- **Resource & Cost Efficiency:** By replacing heavy foils and minimizing additives, Batene's design **slashes material usage per kWh by ~30–50%**. Thicker cells mean fewer layers and components per battery, simplifying assembly. The manufacturing process itself is energy-efficient, and the robust electrodes reduce scrap rates in production. Overall, Batene's technology promises up to **50% reduction in battery production cost** while using less raw metal – a critical advantage as industries seek cheaper and greener batteries.
- **Future-Proof Compatibility:** Batene's metal fiber network works as a platform for **multiple battery chemistries**. It's already demonstrated in lithium-ion cells, but equally can enable next-gen systems like **lithium metal anodes, silicon-rich anodes, solid-state batteries, or even sodium-ion chemistries**. Many of these emerging chemistries are limited by expansion or poor kinetics – exactly the problems Batene's flexible, conductive scaffold solves. The technology is also **chemistry-agnostic and a drop-in** for current gigafactories, which means it can enhance today's batteries and seamlessly adapt to tomorrow's.



Conventional battery cell (left) vs. Batene fleece-based cell (right) with the same amount of active material, demonstrating the fleece cell's higher power output (brighter light).

This visual comparison highlights how Batene's 3D current collector delivers superior performance even with identical chemistry and size – a compelling indicator of the technology's disruptive potential.

Applications and Addressable Markets

Batene's innovation has broad applicability across **energy storage and other sectors**, opening multiple high-value markets:

- **Lithium-Ion Batteries (EVs & Grid Storage):** The immediate target is the booming Li-ion battery market for electric vehicles and stationary storage (annual market >$100B and growing). Battery makers are hungry for technologies that increase energy density and reduce costs. Batene's fleece addresses this directly – e.g. an EV battery pack could achieve the same range with **fewer cells or smaller size**, or significantly extended range with the same footprint. Faster charging and longer cycle life are additional selling points for automakers and battery OEMs. By improving both energy *and* power density, Batene's technology offers a rare dual benefit, giving manufacturers a competitive edge in performance **without changing their supply chain or production lines**. The addressable market here spans EV batteries, consumer electronics (where longer-lasting batteries are always in demand), and grid storage systems that need cost-effective, durable cells for renewable energy buffering.
- **Next-Generation Batteries:** Beyond current Li-ion, Batene positions itself as an **enabler for next-gen batteries**. For example, **solid-state lithium metal batteries** promise high energy density but suffer from dendrites and interface issues; a Batene metal fiber anode could suppress dendrite growth and accommodate volume changes, making solid-state cells safer and more practical. Similarly, silicon-anode cells (with 3-4x the anode capacity of graphite) are limited by silicon's expansion – a flexible metal mesh could prevent pulverization and dramatically improve silicon anode cycle life. Even emerging **sodium-ion batteries** (a growing market for grid use) could benefit from the lightweight conductive scaffold to offset sodium's lower energy density. In each case, Batene's technology can be the key that unlocks the next wave of battery innovations, giving it a stake in future markets (solid-state, post-Li-ion systems) projected to be worth **tens of billions** in the coming decade.

- **Industrial Filtration & Catalysis:** Batene's 3D metal fiber networks aren't limited to batteries – they function as high-performance **porous materials** for other industries. The fine metal fibers can form filters with exceptional surface area and tunable porosity, useful in **filtration applications** (e.g. filtering hot gases or liquids in chemical processing). The irregular, non-round fiber shapes can induce micro-turbulence in flow, leading to better filtration efficiency. Likewise, the **large surface area and thermal stability** of metal fleece make it an excellent substrate for **catalysts** in chemical reactors or fuel cells, where reactions benefit from high surface catalysts on conductive supports. These sectors represent additional revenue streams – for instance, industrial filtration and catalytic converter markets are multi-billion-dollar industries that constantly seek more durable, efficient materials. Batene's technology could command a premium here by outperforming traditional sintered metal filters or catalyst foams.
- **Other Use Cases (EMI Shielding, Electronics):** The conductive fiber mesh can also serve in **electromagnetic interference (EMI) shielding** for electronics, as a lightweight alternative to solid metal sheets. It can be molded to complex shapes to shield sensitive components while adding minimal weight – potentially interesting for aerospace or high-end electronics. Additionally, the material could find use in supercapacitors, sensors, or any application requiring a conductive porous scaffold. While batteries remain Batene's focus, these adjacencies underscore the versatility and scalability of its core material technology.

Importantly, Batene's go-to-market strategy is initially centered on **battery applications**, where the value proposition is strongest. Early beachhead markets include high-performance EV cells and specialty batteries (e.g. for aviation or power tools) where customers pay for premium performance. Success here can springboard the company into other applications like filtration or catalysis via partnerships or licensing, leveraging the same core IP.

Competitive Edge and Scalability

Competition: Batene faces relatively few direct competitors in the current collector redesign space, as most battery startups focus on novel chemistries (new electrode materials, electrolytes) rather than the electrode architecture itself. Traditional battery manufacturers have long recognized the limitation of thin foils, but their attempts at thicker electrodes often falter due to diffusion limits and mechanical strain. Some incumbent

approaches (e.g. using 3D foamed metal current collectors or conductive additives) have improved performance *incrementally* but still struggle beyond ~50% active material before performance drops off. In contrast, Batene's solution is a **holistic re-engineering of the electrode structure**, which has demonstrated **order-of-magnitude improvements** in achievable thickness and active loading (a *factor of 60* more active material in lab tests before capacity drop-off). Another company, 24M, pursues a "thick electrode" semi-solid battery design, but their approach involves new slurry processing and has yet to achieve the same combination of high energy and power. Batene's **patented metal fleece** is unique in providing both **high conductivity and mechanical resiliency in 3D**, and it is protected by multiple filings covering the fiber fabrication, composite structure, and use in electrodes. This gives Batene a **strong competitive moat** in IP. Moreover, the **exclusive license from Max Planck** means world-class research backing and freedom to operate, while competitors would face significant barriers to replicate the proprietary process.

Scaling & Manufacturing: A critical advantage of Batene's technology is that it's designed for **manufacturing scalability**. The metal fiber fleece can be produced via *melt spinning and sintering* in a continuous process, essentially creating rolls of metallic nonwoven fabric. Batene's patents highlight the feasibility of **roll-to-roll production**, which aligns with how current battery electrodes (on foils) are made. The company has already built **cutting-edge R&D labs and pilot production facilities** (opened in 2023 in a renovated textile mill in Wendlingen, Germany) to refine this process. The choice of a former spinning mill is symbolic and practical – it taps into regional expertise in fiber processing while providing industrial space for scaling. Batene is currently producing prototype electrodes and working closely with partners to validate mass manufacturing. The **drop-in nature** of the technology cannot be overstated: battery producers can adopt the Batene fleece with minimal retooling, since it comes in a familiar sheet format and can be coated with active material using standard techniques (e.g. slurry coating or infiltration). This lowers the barrier to scale-up and adoption significantly compared to entirely new battery cell designs.

Additionally, Batene benefits from **strong investor and institutional support** to scale. The company's **€10 million seed funding** (raised in late 2022) is being used to ramp up production capabilities and initiate pilot projects with battery manufacturers. Backing from strategic investors like **Ocean Zero (focused on decarbonizing marine transport)** and the **CEO of Candela (electric boats)** not only provides capital but also opens potential early markets (e.g. electric marine batteries where high performance is needed). Batene's location in Baden-Württemberg – a hub of automotive and engineering firms – also offers

access to skilled talent and automation technology for manufacturing. The company has secured **public innovation grants** (e.g. an €830k award from the state's Invest BW program) to support its scale-up and R&D, reflecting confidence from local government in its growth. All these factors contribute to a clear path for Batene to progress from lab prototypes to **high-volume production** in the coming years.

Team, Traction & Outlook

Batene's team and partnerships give it a formidable foundation. The company was co-founded by **Dr. Thanh T. Nguyen and Prof. Martin Möller**, among others, following 8+ years of research on metal fiber materials at the Max Planck Institute for Medical Research. This deep technical expertise is paired with experienced advisors and investors: the **Max Planck Society itself is a shareholder** and continues to support Batene through its tech transfer arm (Max Planck Innovation). Notably, **Max Planck President Patrick Cramer** and other leaders have publicly lauded Batene's potential to "*disrupt the battery market*" and exemplify successful translation of fundamental research to industry. Such endorsements underscore the credibility of Batene's science.

Since its founding, Batene has hit key milestones indicating strong traction:

- **Funding & Investors:** In addition to the €10M seed round (co-led by **Chris Anderson of TED/Ocean Zero** and **Christer von der Burg**, with participation from **Gustav Hasselskog**), Batene won **prestigious awards** that validate its innovation. It received the **2024 Max Planck Startup Award** (Stifterverband) – a prize recognizing outstanding high-impact startups – along with a €30,000 grant. This award, presented at the Max Planck annual meeting, acknowledged Batene's "groundbreaking development of more powerful and cost-effective energy storage". Such recognition raises Batene's profile among industry and government stakeholders.
- **Partnerships & Visibility:** Batene's lab inauguration in September 2023 was attended by officials and industry partners, including the **Minister of Economic Affairs of Baden-Württemberg**, highlighting public sector support. The startup has been featured in industry media (e.g. PV Magazine, Chemeurope) for its novel approach, helping attract potential customers and talent. Ongoing collaborations with research institutes (Max Planck, universities) and exploratory projects with battery manufacturers are paving the way for commercial pilots.

- **Technical Progress:** Batene has successfully developed prototype battery cells using its fleece current collectors, demonstrating the promised performance improvements (higher capacity, fast-charge ability, stable cycling) in real electrochemical tests. The team is now focused on scaling up electrode sizes and optimizing manufacturing yield. The fact that **Batene's cells can be produced with existing battery production equipment** and have shown tangible performance gains greatly de-risks the technology. The next steps include setting up a pilot production line (to produce larger quantities of fleece electrodes) and securing sample orders with battery makers, which the recent funding and grants are enabling.

With a clear technological edge, strong IP protection, and growing validation, **Batene is poised for significant growth**. The addressable market in Li-ion batteries alone is enormous and rapidly expanding with the EV revolution. By offering a solution that tackles fundamental limitations (energy density, charging speed, cost) without requiring a chemistry breakthrough, Batene has an opportunity to become a key supplier or licensor to major battery manufacturers. Its technology can **extend the performance of existing battery chemistries and accelerate the adoption of new ones**, positioning the company as an indispensable part of the battery value chain.

The Investment Opportunity

Batene represents a compelling **deep-tech investment** at the intersection of materials science and clean energy. The company's innovations in 3D metal fiber networks give it **multiple shots on goal** – initial revenue in the lithium-ion battery space, with upside in next-gen batteries and spin-off applications like filtration and catalysis. Batene's competitive differentiators (dramatic performance gains, IP leadership, integration ease) and its strong support network (Max Planck affiliation, government funding, visionary investors) de-risk the venture and increase the likelihood of market adoption.

The roadmap ahead offers **attractive value inflection points**: validation in commercial battery cells, joint development agreements with battery OEMs, and eventual licensing or acquisition opportunities. As battery demand soars (projected **>10× growth in GWh production by 2030**), technologies that meaningfully improve battery performance and cost will see tremendous demand. Batene is uniquely positioned to supply that need with its ready-to-implement solution. In summary, an investment in Batene GmbH is an investment in the **future of energy storage** – one that promises not only high returns as the company

scales, but also a transformative impact on sustainable technology globally.

Batene's vision is "electrifying anytime everywhere," and with its advanced composite metal fiber networks, it aims to make that vision a reality by powering a new generation of batteries that are denser, faster, safer, and greener. This optimistic yet realistic trajectory makes Batene a standout opportunity in the battery innovation landscape.

References

1. Batene GmbH – *Company Website*: "Our Technology – batene fleece™ makes battery cells thicker, faster, safer, and resource-efficient" batenetec.combatenetec.com.
2. PV Magazine – Marija Maisch (Nov 9, 2022): "Max Planck spinoff making metal mesh electrodes for lithium-ion batteries" – Describes Batene's metal fleece current collectors enabling 2 mm electrodes (10× thicker), ~90% active material, faster charging, improved safety pv-magazine.compv-magazine.com.
3. Chemeurope News (Nov 16, 2022): "Max Planck spin-off develops more efficient batteries – Batene starts with ten million euros in seed financing" – Confirms >90% active material (metal content cut to one-tenth), larger surface area for faster charge, lower resistance, and potential for solid-state and sodium-ion batteries chemeurope.comchemeurope.com. Also notes €10 M seed round and investors, plus other use cases like filtration, EMI shielding, catalysis chemeurope.comchemeurope.com.
4. Batene Press Release (Max Planck Innovation, June 13, 2024): *"Batene receives the renowned Max Planck Start-up Award for innovative battery technology"* – Highlights Batene's technology increasing battery energy up to 80%, cutting costs ~50%, developed at MPI for Medical Research max-planck-innovation.commax-planck-innovation.com. Mentions founding (March 2022), Max Planck exclusive license/shareholding, and award details max-planck-innovation.commax-planck-innovation.com.
5. Batene News (Feb 19, 2024): "Batene honored with the Max Planck-Startup Award" – Notes the €30k prize recognizing Batene's innovation and its societal impact batenetec.com.
6. Batene News (Sept 20, 2023): "Grand opening of Batene's cutting-edge

laboratories" – Reports opening of R&D labs in Wendlingen's historic Neckarspinnerei with support from regional government (Economic Affairs Minister) batenetec.combatenetec.com.

7. Batene News (June 2, 2023): "Batene receives significant innovation funding from Invest BW program" – Announces ~€830k public funding from state of Baden-Württemberg to accelerate Batene's technology towards market batenetec.com.
8. Patent Application WO2024/100262A1: **"Composite Network Structure"** – Batene's patent-pending design of a porous metal fiber first layer sintered onto a conductive second layer, providing mechanical support and areal current collection. Describes improved mechanical strength and electrical stability, and compatibility with roll-to-roll production.
9. Patent Application WO2024/100261A1: **"Three-dimensional network of metal fibers and production method"** – Covers Batene's process for creating 3D metal fiber fleeces. The technology yields ultrafine metal fibers (≤10 µm) sintered into a network, offering large surface area (beneficial for electrochemical reactions and dendrite suppression). Emphasizes that fine fibers and non-round cross-sections improve filtering and electrochemical performance.
10. Patent Data (EP4368314A1 / EP4584036A1 family) – Experimental results from Batene's patent show a fiber-network electrode achieved **~50% higher capacity** in a Li-ion half-cell vs. a conventional foil electrode (with identical active material), and maintained nearly constant capacity over 50 cycles due to better stress distribution during ion intercalation. This validates the performance and longevity claims of the Batene fleece design.
11. Bundestag Report (2023) – German Federal Parliament document on renewable energy spinoffs, listing **Batene's cap table and funding**: founded 1 March 2022; Max Planck Society holds 7.6%, founders ~63.2%; investors Ocean Zero 11.9%, Christer von der Burg 11.9%, Gustav Hasselskog 5.4%; total seed investment ~€10 M dserver.bundestag.de. This underlines the strong financial backing and stakeholder commitment behind Batene.