ADVANCED AND GREEN PROCESS/EQUIPMENT

Energy Storage Graphene Supercapacitor

Supercapacitors, a type of energy storage component that is safer, more durable, and capable of faster charging and discharging than lithium batteries, typically have lower voltages (2.7V). Our institute's versions, made with 'plasma synthesized graphene' reach higher voltages (4V), increasing energy density and reducing the module size by over 50%.

Technical Advantages and Features

High-Voltage Supercapacitor

- Using plasma-synthesized graphene, which has stable internal chemical properties and no surface functional groups, we've developed a high-voltage (4V) supercapacitor module.

High Energy Density

- Plasma-synthesized graphene, paired with our proprietary lithium-ion electrolyte, offers excellent affinity, quick charge exchange, and faster reactions, enabling higher energy storage (high energy density) in the same volume.

Reduce Module Size

- High energy and power density halve module size and drastically shorten charging time (from 5C to 100C) while ensuring safety and boosting commercial value.

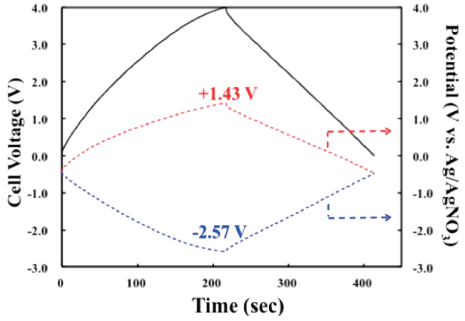
Industrial Benefits and Business Opportunities

- **Industry Applications:**

  Industry Applications: Storage Industry, Electric Vehicle Industry, Electronics Industry.

- **Application Examples:**

  Supercapacitor modules with plasma-synthesized graphene and self-developed lithium-ion electrolyte enable ultra-fast charging and discharging, making them ideal for high-torque and high-load electric vehicles. Demonstrated successfully in Xiluo transport vehicles and Kaohsiung light rail trams, these modules replace traditional lead-acid or lithium batteries, reduce charging time to 20 seconds, and mitigate air pollution and noise from conventional vehicles.



High-Voltage (4V) Graphene Supercapacitor

Xiluo Electric Fruit and Vegetable Transport Vehicles

Kaohsiung Light Rail Tram

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High Efficiency Microwave Heating Technology

For precision heating requiring strict temperature control, electric or combustion indirect heating is commonly used, resulting in higher pollution and prolonged heating cycles. Microwave heating technology allows the wavelength to directly penetrate and heat the material, leading to localized temperature increases, reduced annealing temperatures for semiconductors, and shorter times to reach target temperatures. Furthermore, advancements in process control are needed to ensure precise temperature uniformity.

Technical Advantages and Features

Multi-Mode

- By adjusting the spatial arrangement of microwave electric fields and signals, the number of modes increases fourfold, enhancing the objectivity of analysis results.

Energy-Efficient at Low Temperature

- Microwave annealing, a low-temperature process with workpiece temperatures half those of traditional RTA or laser methods, saves at least 50% in energy.

Enhance Uniformity

- Product uniformity exceeds 99%, meeting the semiconductor industry's standard (approximately 99%).

Industrial Benefits and Business Opportunities

- **Industry Applications:**

  Drying processes in the Food Industry, material heating in the Chemical Industry, and wafer annealing in the Semiconductor Industry.

- **Application Examples:**

  In the food industry, this technology enhances baking processes by saving 30% on electricity and reducing heating times by over 50%. Additionally, it has been proven in semiconductor factories using low-temperature microwave annealing to improve uniformity and reduce annealing costs by approximately 50%.

2017 R&D 100 WINNER

Microwave Heating Machine

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Cloud Management System for Motors and Machinery Energy Efficiency

Existing factories have not fully optimized their capacity and power planning. During off-peak or low-load times, motors and power machinery such as pumps, fans, and compressors often run at full capacity, resulting in significant energy waste. These devices, the main power source of factory operations, present considerable potential for optimization and energy savings with prolonged use.

Technical Advantages and Features

Cloud-Based Mechanical Energy Management

- Using stand-alone external sensors for non-invasive measurement, this method assesses factory energy consumption without requiring downtime or disrupting production.
- An open cloud-based management system provides test results and updates monitoring every 5 seconds to ensure optimal performance.

Customized Service

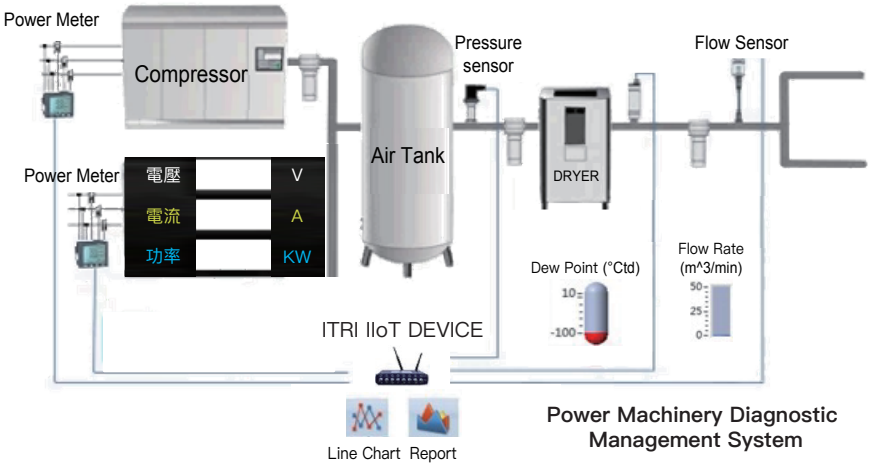
- Customize equipment specifications based on enterprise features.
- Supports common communication databases (ISO, IEC, NEMA, OPCUA, etc.), ensuring compatibility with existing customer systems.

High Energy-Saving Rate

- Providing precise energy-saving recommendations, with over 300 on-site diagnostic cases handled.
- Helping clients save energy, exceeding international standards by over 15%.

Industrial Benefits and Business Opportunities

- **Industry Applications:**
  The Steel, Food, Textile, and Electronics Industries utilize high-energy power equipment, such as motors, air compressors, and pumps.
- **Application Examples:**
  We have advised over 100 factories, including electronic, textile, and petrochemical plants, and established 106 high-efficiency motor technology demonstration sites, achieving energy savings of over 15%.



Power Machinery Diagnostic Management System

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Active Smart Battery Energy Storage Management System

Electricity generation from renewable energy, characterized by intermittency and decentralization, necessitates energy storage systems for optimal distribution and use. This technology utilizes active smart energy management, including intelligent battery capacity forecasting, proactive energy balancing across batteries, and demand–supply optimization, enhancing the overall efficiency of renewable power.

Technical Advantages and Features

Optimized Battery Management

- Stacked battery monitoring with ±1 mV accuracy (typically ±10 mV).
- Active battery balancing maintains consistent voltages across units, supporting currents up to 10 A (typically 100 mA).

Energy Management System Enhances Energy Storage Capacity

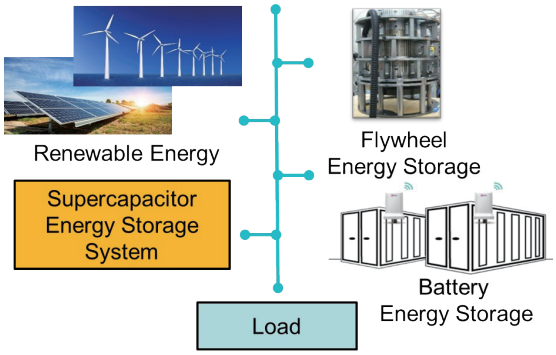
- Buffering power with a renewable energy storage system reduces grid impact.
- Increasing renewable energy storage capacity by over 17%.

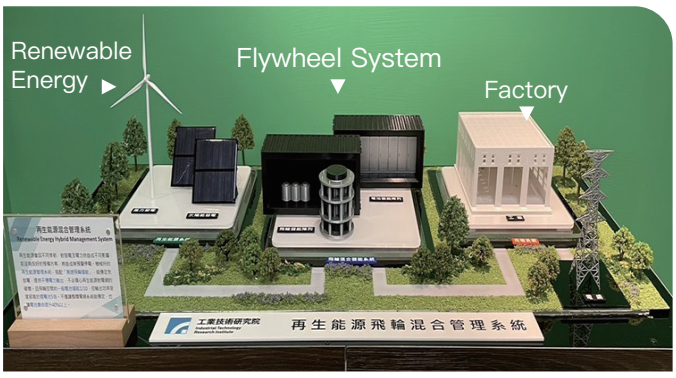
Electrical Load Management

- Electricity is effectively stored and utilized during peak (daytime) and off–peak (nighttime) hours for peak shaving.
- Instant response to power demand and time distribution.
- Saving more than 10% on electricity bills.

Industrial Benefits and Business Opportunities

- **Industry Applications:**
  Energy Storage Industry and Green Energy Industry.
- **Application Examples:**
  Widely used in the energy storage and green energy industries, this technology collaborates with Taiwan's energy system integrators on various green power projects. It enables enterprises to save up to 20% on electricity, reduces energy costs by 10%, boosts renewable energy storage by over 17%, and is projected to yield billions in New Taiwan Dollars for the green energy industry.





Renewable Energy Storage Grid Diagram

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Precision Elastic Product Collaboration Design and Development Technology

Precision elastic materials, such as springs and seals, possess high precision and elasticity. Extensively used in the rubber, plastics, and textile industries, the elasticity complicates precise automated control, potentially affecting product quality. This technology enables the development of collaborative automated processes for elastic materials.

Technical Advantages and Features

Intelligent Clamping Fixture

- An intelligent clamping device automatically adapts to the workpiece shape, reducing positioning errors and maintaining stability at the target position and orientation.

Fully Automatic Integration

- Analyzing object motion trajectories based on different elastic materials and automatically managing movement, adhesion, and positioning within 7 seconds.

Intelligent Image Analysis

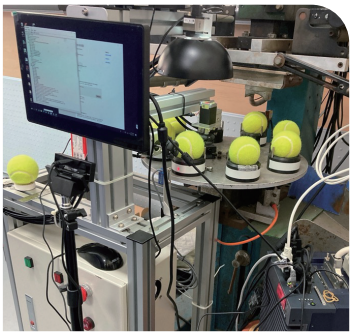
- Providing image analysis of posture to enhance alignment precision.
- Automatically aligns and identifies the best production design solution within 5 seconds.

Industrial Benefits and Business Opportunities

- **Industry Applications:**
  Rubber and Plastic Industry, Food Packaging Industry, Textile Industry, etc.
- **Application Examples:**
  This technology, adopted by leading domestic sports equipment manufacturers, has enhanced factory automation, boosted production efficiency by 50%, successfully facilitated entry into international markets, and established supply chains.

Precision Tracing Collaboration Equipment

Flexible Material Transfer, Adhesion/Positioning Fully Automatic Integrated Equipment



Precision Alignment Drive Module

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Plasma Diagnostic Technology

Plasma processing is a technique that utilizes plasma for material processing and surface treatment. The main issue currently faced by plasma processing is the absence of real-time measurement technology, leading to inadequate process control. As a result, engineers are unable to quickly identify the factors affecting yield, which hinders process optimization and the development of new technologies.

Technical Advantages and Features

Langmuir Probe Measurement Module

- Multiple probes on the electronic test equipment fully measure important plasma parameters (plasma density, electron temperature, plasma potential, electron energy distribution function, etc.).
- Plasma density measurement range: 10^{9}~10^{12} cm^{-3}.

Non-Invasive RF Ion Diagnostic Module

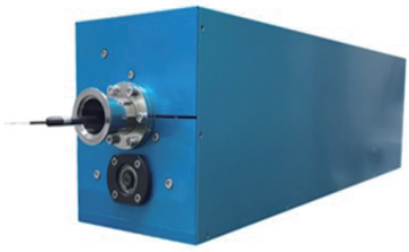
- The module analyzes the wafer surface's ion energy and flux in real time.
- Updated rate: 5 times per second.

End-Point Detection Module

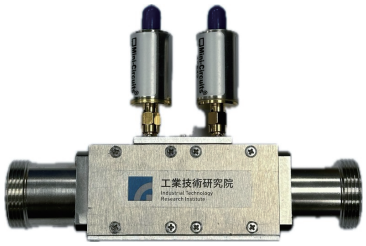
- Precision identifies etch endpoints, such as low etching exposure areas and complex operations, to achieve a recognition rate over 90% (typically, the recognition rate is less than 70%).

Industrial Benefits and Business Opportunities

- **Industry Applications:**
  Plasma Processing Equipment Industry (e.g., plasma etching, coating, cleaning), Optoelectronic Semiconductor Manufacturing Industry (e.g., process monitoring and parameter optimization).
- **Application Examples:**
  Introduced to domestic optoelectronic semiconductor equipment manufacturers. In collaboration with these manufacturers, ITRI has jointly conducted verification of new product development. Additionally, the technology provides universities, such as National Tsing Hua University, with a fundamental research tool for plasma technology.



Langmuir Probe



Non-Invasive RF Ion Diagnostic

End-Point Detection

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Thin Film Process Optimization Simulator Technology

Thin film deposition is a process that applies a thin film to the surface of a material. The thin film coating process for complex nanodevices lacks simulation analysis tools for auxiliary processes, such as temperature, airflow, pressure, and electromagnetic fields. This deficiency results in the inability to effectively obtain optimal parameters, thereby affecting the product development timeline and increasing expenditures.

Technical Advantages and Features

Multiple Physics Coupling Technology

- The unique "Surface Chemical Reaction Pathway Decision-Making Technology" simplifies the chemical equation and obtains real data feedback for correction.
- Visual verification of flow field and AI quality calculation prediction tools for diagnostic parameters.

Shortening the Equipment Development Timeline

- A massive database obtains recommended optimal parameters (2 hours vs. 1 week).
- The accuracy of parameter prediction > 90%; shortened the time to market (1 month vs. 3 months).

Improving Productivity and Quality

- Enhancing machine capacity.
- Improving deposition uniformity.

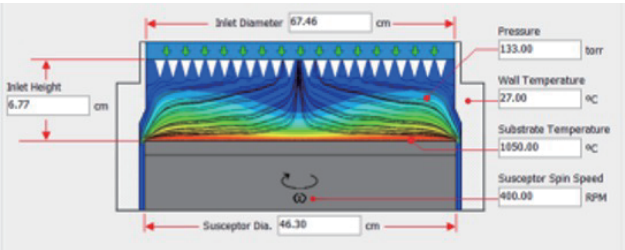
Industrial Benefits and Business Opportunities

- **Industry Applications:**

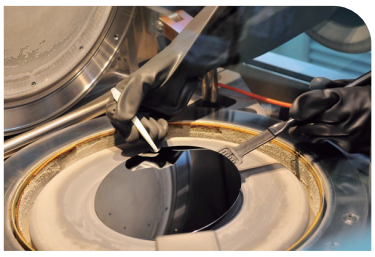
  Thin film equipment, such as MOCVD、PECVD、PVD, in the Optoelectronic Semiconductor Industry, such as LED, semiconductor, solar, and wireless communication.

- **Application Examples:**

  In collaboration with major domestic ODMs in semiconductor equipment, we aim to become a key component of the international supply chain by continually conducting technological R&D, thereby enhancing the quality of our deposition equipment.



The UI of Thin Film Deposition System



Key Modules of the Deposition Equipment

ITRI Outstanding Research Award in 2021

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High Aspect Ratio TGV Filling Technology

Advanced packaging substrates are transitioning to TGV glass substrates, replacing current polymer materials (e.g. ABF, BT), to align with the future trends of fine line spacing and high aspect ratios. TGV glass substrates offer excellent thermal conductivity, high stability, and corrosion resistance. However, when filling high aspect ratio holes in glass substrates, issues such as uneven porosity and coating layers can occur, affecting product quality.

Technical Advantages and Features

Adhesion Promoting Layer

- Synthesis of low-viscosity composite metal oxide solution.
- Formation of nano-micro porous structures.
- Adhesion ≥ 5 N/cm.

Copper Filling Within a High Aspect Ratio of Low void rate and H-Shaped

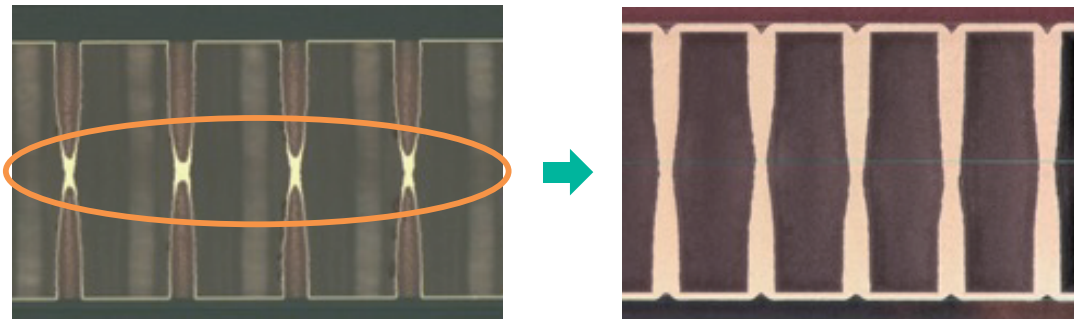
- Pioneering H-shaped electroplating for bridge hole filling.
- Filling in high aspect ratios >15.
- Plating defects < 5%.
- Applicable to different types of holes (e.g., straight hole, X hole, and funnel hole).

High Uniformity Low Plating Thickness

- Low face copper thickness (copper thickness <1/3 hole diameter).
- High uniformity (~ 90%).
- Applicable for 8”-12” TGV glass substrate.

Industrial Benefits and Business Opportunities

- **Industry Applications:**
  PCB, Advanced Semiconductor Packaging, Display Equipment.
- **Application Examples:**
  This technology, designated as a cooperating partner by domestic and foreign high-end carrier board manufacturers, reduces process time by 20% and completes products with aspect ratios exceeding 15. It has successfully entered the international supply chain.



H-Shaped Electroplating Bridge

Copper Filling by Electroplating for High Aspect Ratio

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Lapping and Polishing Technology for Hard & Brittle Materials

Processing hard and brittle materials, particularly silicon carbide (SiC), is crucial in the next-generation semiconductor industry. Due to the extreme hardness of SiC, the threshold for processing technology has increased. The processing time is now 10 times longer than before. Consequently, specialized processes and equipment have been developed to ensure production efficiency and quality.

Technical Advantages and Features

Ultrasonic-Assisted Roller Grinding

- Maintain sharpness by using the ultrasound induced vibration.
- With a special high-precision grinding wheel (#8000), the grinding speed of SiC is twice as fast as before.
- The surface roughness meets the industry demand of <5 nm.

Plasma Assisted Polishing

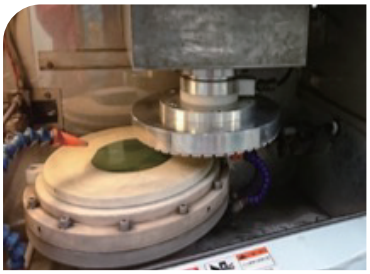
- Through plasma-assisted polishing, the surface of SiC is oxidized and softened.
- The polishing rate has increased by 5 times.
- Applicable for processing 4”- 8” wafers.

Hybrid Metrology High-Resolution

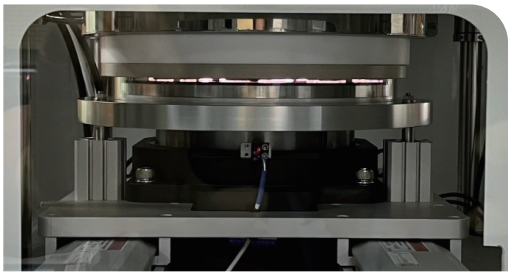
- A Single-machine of multi-parameter composite measurement, including SiC wafer's bending, warping, thickness, and roughness. (Typically requires 2 machines)
- The resolution of surface morphology/thickness meets the industry demand of 0.1 μm.
- The resolution of roughness measurement meets the industry demand of <10 nm.
- Applicable for processing 6”- 12” wafers.

Industrial Benefits and Business Opportunities

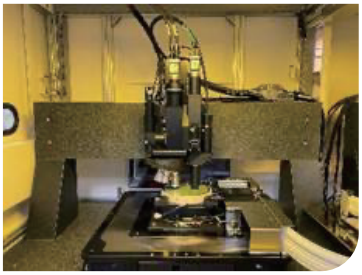
- **Industry Applications:**
  Semiconductor industry (Front-end, such as Sapphire, SiC, etc.).
- **Application Examples:**
  Applied to domestic machine tool factories and SiC processing industries, this assists enterprises in enhancing production efficiency and increasing industrial competitiveness.



Ultrasonic Assisted Grinding



Plasma Assisted Polishing



Hybrid Metrology Technology

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