

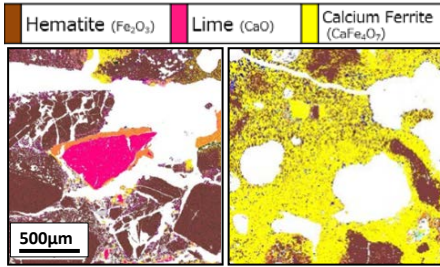
# Materials Research Laboratory

Our important contributions to the business divisions are made by strengthening their competitiveness and by the creation of new products. New products have been developed in the materials field by means of sophisticated materials and surface design technologies. In addition, manufacturing processes have been optimized. Advanced technological support is provided to the development of new products in the machinery field. Furthermore, our proprietary material technologies provide a firm base for the development of new business ventures.

## Refining & Solidification

- Control of Inclusions in Metals
- Melting & Casting Process
- Metallurgical Reaction Analysis
- Slag Morphology and Structure Control

Achieved optimum process and high-quality products using process simulation and reaction control technology.

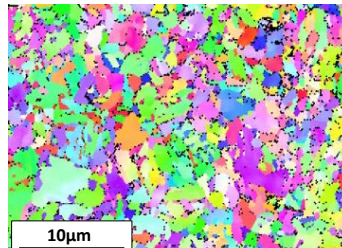


Mineral Phase Mapping

## Materials Design

- Strength and Ductility Control
- Advanced Microstructure Control
- Material Function Control
- Structural Material Design

Developed materials for next-generation lightweight vehicles using nano/micro level microstructural control technologies and materials design.

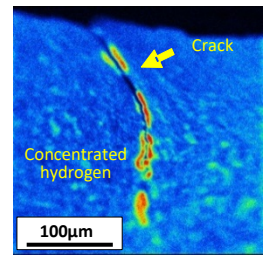


Microstructural Analysis (µm scale)

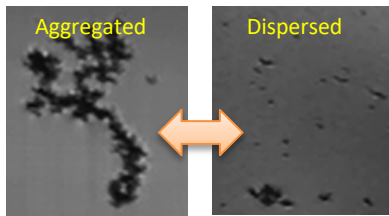
## Mechanical Working

- Modeling and Design of:
  - Rolling Process
  - Cutting and Grinding Process
  - Forging Process
  - Extrusion process

Improved anti-corrosion characteristics and reduced life-cycle cost using embrittlement/pitting corrosion behavior analysis technology.



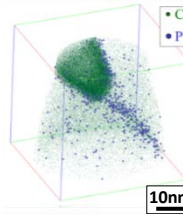
Analysis of Embrittlement Behavior



Control of Inclusion Morphology

### Applications to Products and Processes

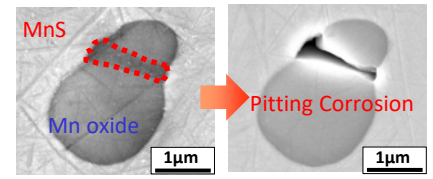
- Reduction of CO<sub>2</sub> emission
- Engine valve springs for automobiles
- Engine crankshafts for ships
- Aluminum disks for hard disk drives
- Copper alloys for electronic parts



Nano-structure Analysis (nm scale)

### Applications to Products and Processes

- High-strength steel sheets and aluminum panels for automobiles
- Fatigue-resistant steel for shipbuilding
- Low-temperature welding wire



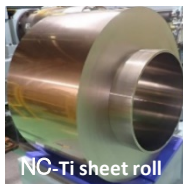
Pitting Corrosion Analysis

### Applications to Products and Processes

- High-strength steel sheets for automobiles
- High-strength bolts

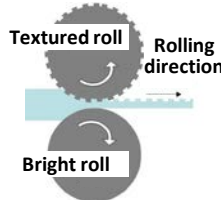
"NC-Titanium®" sheet for FC bipolar plate with excellent corrosion resistance and surface conductivity has been commercialized by developing composite layer of Ti oxide and nano-sized carbon.

Awarded Sokeizai Industry Technology Award  
"Minister of Economy, Trade and Industry Award"

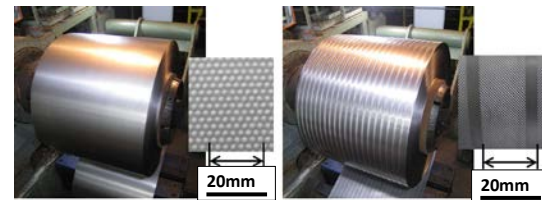


NC-Ti sheet roll

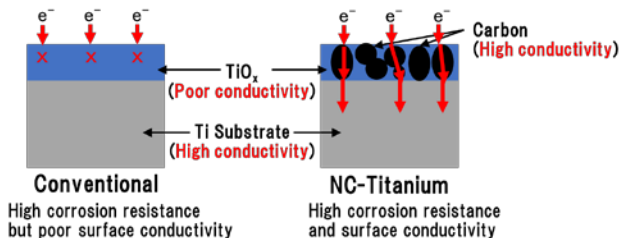
Process optimization of rolling / forging / cutting by laboratory experiment and numerical simulation estimating and measuring temperature, stress, materials function and morphology.



Ordered profile transfer



HEET™: High heat-transfer Ti plate



Conventional

NC-Titanium

High corrosion resistance but poor surface conductivity

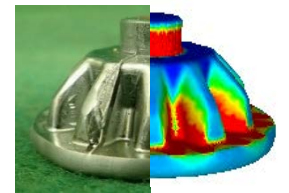
High corrosion resistance and surface conductivity



300T press



Forging die



Experimental FEM simulation

Comparison between simulation and production

### Trial production of cold-forged gear

### Applications to Products and Processes

- Power generators, Heat exchanger plates
- Cold forging process design and trial production of high tensile strength steel

### Rolling Technology and Surface Design

### Applications to Products and Processes

- Fuel cell vehicle bipolar plate