

# Mineral Resources Business

SMM uses the technology accumulated from operating Besshi Copper Mine (opened in 1991) and incorporates it in operations of Hishikari Mine (opened in 1985) and Pogo Gold Mine (opened in 2006). Additionally, SMM acts as a professional mine developer and operator seeking out superior resources in regions around the world, while participating in mining operations, pursuing myriad exploration projects, and proceeding with surveys to develop new mines.

Naoyuki Tsuchida

Senior Managing Executive Officer  
General Manager,  
Mineral Resources Div.



## Reflecting on the 2012 3-Year Business Plan

### Sierra Gorda Copper Mine development project

- We were able to start commercial production in July 2015, though delays in launching operations meant that full production was not reached.
- Surging capital expenditures, delays in launching operations, and weak copper prices led to impairment losses booked in FY2015.

### Increased production and stable operations at current operating mines

#### ● Cerro Verde Copper Mine expansion project

The expansion project proceeded according to plan and full production was started in March 2016.

#### ● Morenci Copper Mine expansion project

The expansion project proceeded according to plan and full production was started in May 2015.

#### ● Hishikari Mine lower ore body development project

Construction of a new dewatering facility is proceeding in order to develop lower ore bodies present below the current depth of the hot spring water level. We expect approximately 30 tons of gold from this project.

#### ● Pogo Gold Mine East Deep

We proceeded with development of the East Deep deposit and began full-fledged production from the first quarter of FY2014.

### Acquiring interests in new projects

- With Morenci Copper Mine, we acquired an additional 13% interest in this, one of the world's largest copper mines, from our partner Freeport McMoRan, boosting our interest to 25%.
- Though exploration activities focusing on the Pacific Rim have been carried out, no promising discoveries leading to mine development were made.
- Though a large number of projects have been studied to evaluate the acquisition of interests, no acquisitions leading to mine development were made.



## Corporate strategies in the 2015 3-Year Business Plan

### Sierra Gorda Copper Mine development project

- While promoting mutual understanding among shareholders and taking direct involvement with on-site management, we will put full effort into securing stable operations and broad cost reductions.
- We will proceed with reviews of the oxide ores project and 2nd Phase expansion project in order to raise future business prospects.

### Acquiring interests in new projects

- With the aim of achieving the attributable annual production targets of 300,000 tons of copper and 30 tons of gold by FY2021, we will be engaged in both explorations of various stage projects and acquisitions of advanced stage projects.
- With respect to gold in particular, which is significantly deviating from our long-term target level, both independent explorations and acquisitions will be priority issues to gain the additional gold reserves.

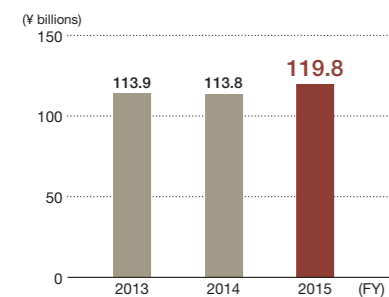
### Stable operations at current operating mines

- Along with achieving stable operations at current operating mines while moving forward with cost reductions, we will strive to secure financial profits.
- We will continue with peripheral exploration of Hishikari Mine and Pogo Gold Mine, striving to extend the lives of both mines.
- We will proceed with constructing a new dewatering facility in order to continue developing lower ore bodies at Hishikari Mine.

## FY2015 review

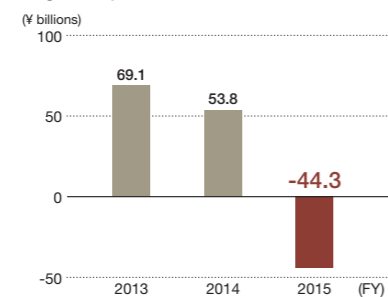
- Operations at Hishikari Mine proceeded on a stable basis, producing 6.9 tons of gold.
- Operations at Pogo Gold Mine produced 8.8 tons of gold due to a decline in the ore grade.
- A verdict was handed down on the appeal over our international tender for mining zones in the Solomon project.

Net sales



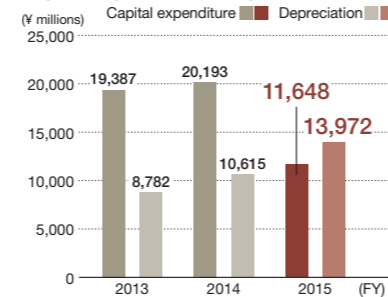
Launching our expansion projects boosted production and sales volumes above the previous fiscal year.

Segment profit



The fall in metal prices and the impairment losses booked at Sierra Gorda Copper Mine led to ¥44.3 billion in losses.

Capital expenditure / depreciation

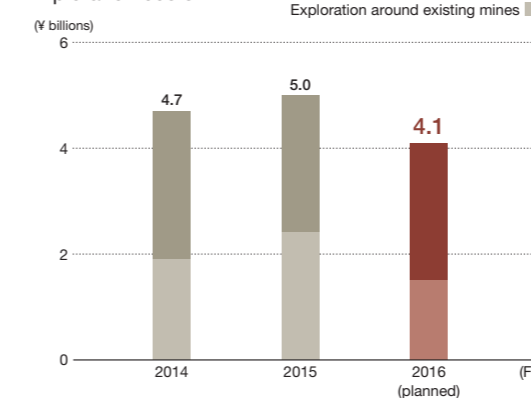


Capital expenditure, including large-scale projects, proceeded basically as planned.

## FY2016 outlook

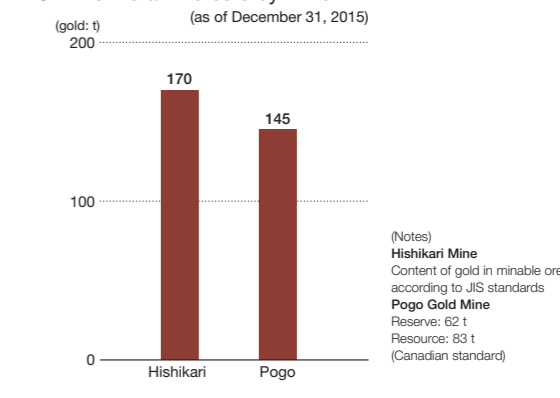
- We will continue dedicating maximum effort toward achieving full operation at Sierra Gorda Copper Mine as soon as possible.
- FY2016 production at Hishikari Mine is scheduled for 6 tons.
- FY2016 production at Pogo Gold Mine is scheduled for 9 tons.

Exploration costs



In 2016, we will proceed with exploration focused on gold and will dedicate further effort to exploration around mines already in operation.

SMM's metal interests by mine



Metal reserves by mine, calculated as of December 31, 2015, are 170 tons (no change from last fiscal year) at Hishikari Mine and 145 tons (down 19 tons from last fiscal year) at Pogo Gold Mine.

### External environmental factors with a significant impact on SMM's mineral resources business

- Declining profitability due to weak metal prices
- Financial damage or movements toward asset restructuring/reorganizing at major resource companies
- Increased and accelerated resource monopolization by certain countries
- Increased risks of higher taxation, etc. from a rise in resource nationalism
- Increased development and operation costs from a decline in deposit ore grade, or from deposits being increasingly located in high-lying, remote, or deep locations
- Increased development and operation costs from more serious environmental problems and more stringent regulations

### Core advantages of SMM's mineral resources business

#### Accumulated mining and exploration technology

The level of engineers' technical skill and expertise impacts the stability and improvement of mine operations. While the SMM Group utilizes its domestic mine, Hishikari Mine, as a base for nurturing mining engineers, we also dispatch engineers to the Pogo Gold Mine that we operate, in addition to overseas mines where we have minor interests. This allows us to foster human resources with expertise in mine exploration, development, and operation.



Daily operation and management at Hishikari Mine

#### Robust relationships of trust with our partners

In preserving our mine interests, the SMM Group goes beyond mere investment and leverages the technical expertise honed and developed since building out the Besshi Copper Mine to contribute to stable and improving operations. This includes dispatching employees and forming cooperative technology relationships, all of which allows us to earn a high degree of trust from our partners. The bedrock of reliability created through these and other activities provides opportunities to participate in new, high-quality development projects and to acquire new interests. This progress leads to further growth and improvement in our corporate value.



Freeport McMoRan President Adkerson and SMM President Nakazato at the ceremony celebrating the acquisition of additional interest in Morenci Copper Mine (June 3, 2016)

#### Co-existing with local communities

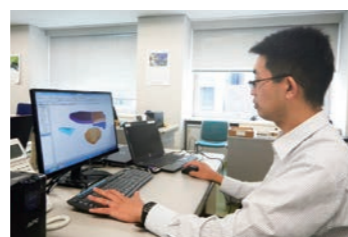
While carrying out dialogue with stakeholders, we strive to listen to the needs and concerns of local communities so that we can develop and operate mines in harmony with these groups. By avoiding conflicts with the needs of local communities regarding, for instance, water resources, and by processing mine wastewater, reducing dust, and safely managing deposition fields for tailings, we strive for responsible environmental management that contributes to environmental preservation.



Daily environmental surveys around Hishikari Mine

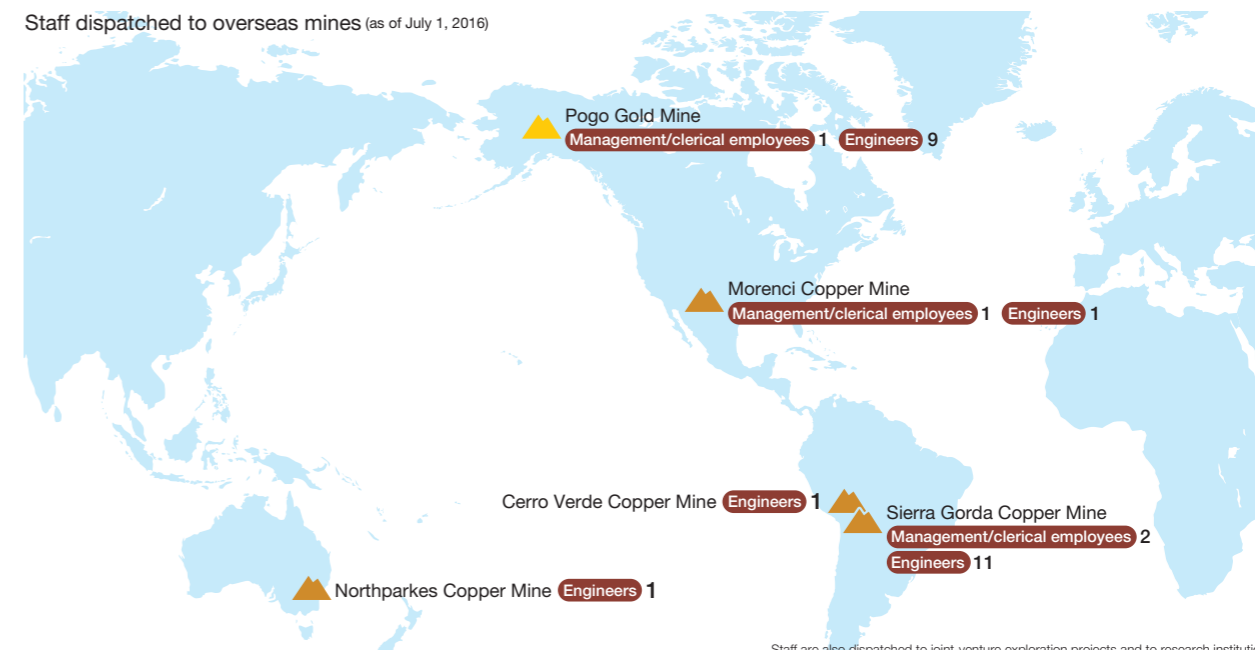
#### High-precision techniques for evaluating profitability

In order to ensure profit even in the face of fluctuating metal prices, we set stringent investment criteria and strictly evaluate profitability when acquiring mine interests. Leveraging massive amounts of mine-related information accumulated over many years allows us to exercise a high level of precision in these calculations of reserves, investment amounts, and other risks, which are the foundational techniques for profitability evaluations. Profitability assessments based on results of these highly precise evaluations contribute to minimizing financial risks accompanying interest acquisition and are fundamental to a stable supply of basic, raw materials.



Project evaluation by engineers with highly specialized knowledge

Staff dispatched to overseas mines (as of July 1, 2016)

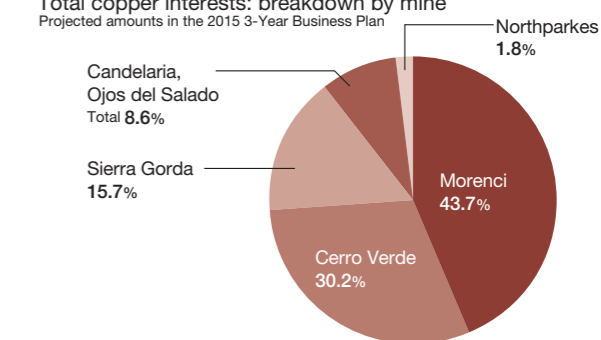


Staff are also dispatched to joint-venture exploration projects and to research institutions.

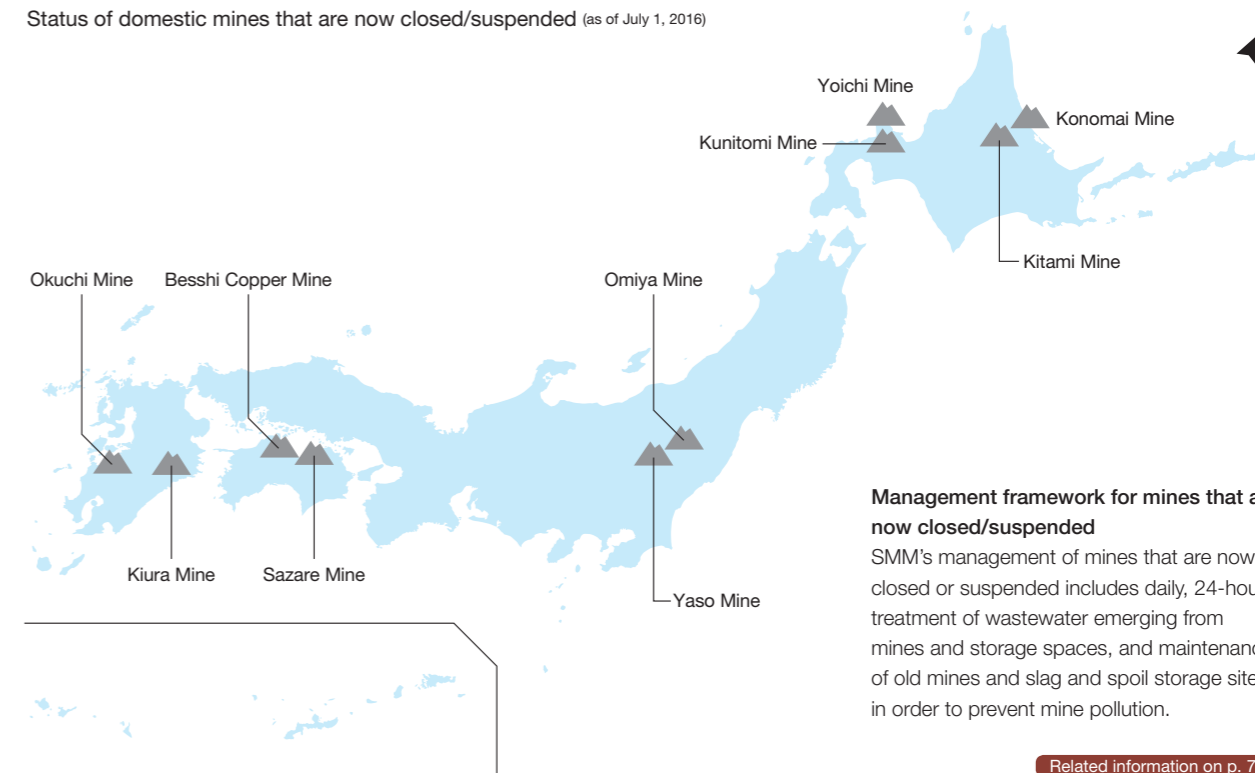
#### Copper mines and interests in which SMM has ownership

Copper mine name	SMM interest
Morenci	25.0%
Cerro Verde	16.8%
Sierra Gorda	31.5%
Candelaria	16.0%
Ojos del Salado	16.0%
Northparkes	13.3%

#### Total copper interests: breakdown by mine



#### Status of domestic mines that are now closed/suspended (as of July 1, 2016)



#### Management framework for mines that are now closed/suspended

SMM's management of mines that are now closed or suspended includes daily, 24-hour treatment of wastewater emerging from mines and storage spaces, and maintenance of old mines and slag and spoil storage sites, in order to prevent mine pollution.

Related information on p. 71

# Smelting & Refining Business

SMM smelts and refines raw materials procured from a variety of sources, mainly from mines where we have an interest, into such metals as copper, nickel, and gold. SMM possesses world-class smelting and refining technology and has forged a solid position within its industry. As an example, SMM became the first in the world to successfully commercialize HPAL technology for the recovery of nickel from low-grade ore, which had been difficult with conventional technologies.

Akira Nozaki

Managing Executive Officer  
General Manager,  
Non-Ferrous Metals Div.



## Reflecting on the 2012 3-Year Business Plan

### Establishment of a 100,000-ton Nickel Production Structure

#### ● Taganito Project

We moved forward with construction on Mindanao Island (Philippines) of Taganito HPAL Nickel Corporation as our second production base that uses high-pressure acid leach (HPAL)<sup>1</sup> process to produce nickel-cobalt mixed sulfide (MS), a type of nickel intermediate. Production began in FY2013 and reached a stable level in FY2014, contributing to our establishment of a 100,000-ton nickel production structure.

#### ● Strengthening HPAL competitiveness

We investigated using the HPAL process to recover scandium, chromite, and hematite, which had been difficult to recover, built a pilot plant, and carried out assessments for some users.

#### ● Establishment of a 65,000-ton electrolytic nickel production structure

We expanded production capacity at the Niihama Nickel Refinery (Ehime Prefecture), establishing a 65,000-ton/year production structure in FY2014.

#### ● Expanding nickel sulfate production

We built nickel sulfate production facilities at Harima Refinery and began production from FY2014. Along with the Niihama Nickel Refinery, this gives SMM two production bases for responding to the increasing demand for use in battery materials, etc.

### Strengthening the competitiveness of the Toyo Smelter & Refinery (copper smelting and refining)

- We expanded capacity for handling secondary raw materials.
- We proceeded with initiatives to strengthen our ability to handle impurities.
- We proceeded with initiatives for stable operations and further cost reductions.



## Corporate strategies in the 2015 3-Year Business Plan

### Stable nickel production of 100,000 tons and promotion of a 150,000-ton production structure

#### ● Increasing production capacity at Taganito HPAL

We plan to increase production capacity 20% at Taganito HPAL and begin production on the scale of 36,000 tons in the second half of 2018.

#### ● Strengthening HPAL competitiveness

We plan to build a scandium production plant at Taganito HPAL and begin commercial production from 2018. With regard to chromite and hematite, we are continuing tests and considering commercialization.

#### ● Pomalaa Project

We are moving forward with reviews of the area around Pomalaa, Indonesia as a candidate for our third MS production base using the HPAL process. By processing nickel ore to a higher degree on site, we are working to respond to the requirement to create high value-added minerals, which is one of the major policies of the new Indonesian law on resource extraction (Law on Mineral and Coal Mining).

#### ● Expanding nickel sulfate production

At Harima Refinery, we plan to take production capacity of nickel sulfate, earmarked for battery materials, and expand from the current 20,000-ton/year structure to a 45,000-ton/year structure in FY2016, then a 49,000-ton/year structure in FY2018.

#### ● Building a production structure optimized for ferro-nickel

At Hyuga Smelting Co., Ltd., we have set in place a 14,000-ton/year production structure optimized for ferro-nickel production. By transitioning from a 2 kiln, 2 electric furnace operation to a 2 kiln, 1 electric furnace operation, we aim to secure profitability from cost reductions and efficient operations.

### Strengthening the competitiveness of the Toyo Smelter & Refinery (copper smelting and refining)

- We will strive to lift profitability by achieving full operation at a capacity of 450,000 tons, a historical high for the Company. Additionally, we will work to maximize production volume in order to take the greatest advantage of the positive external factor of rising TC/RC<sup>2</sup> rates.
- We are moving forward on improving profitability by further upgrading production technology, strengthening our ability to handle impurities, enhancing our ability to pick up secondary raw materials, and reducing costs.

## FY2015 review and FY2016 outlook

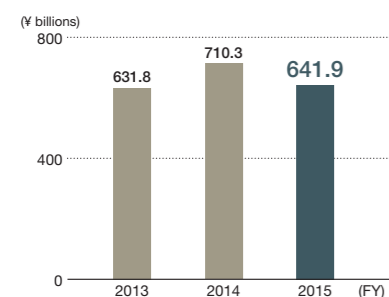
### FY2015 review

- With the transition to nickel sulfate production, we stopped production of prime western grade zinc at the Harima Refinery in September 2015.
- Production of electrolytic nickel proceeded smoothly and amounted to 66,000 tons.
- We carried out regular maintenance at the Toyo Smelter & Refinery, with electrolytic copper production coming to 420,000 tons as planned.

### FY2016 outlook

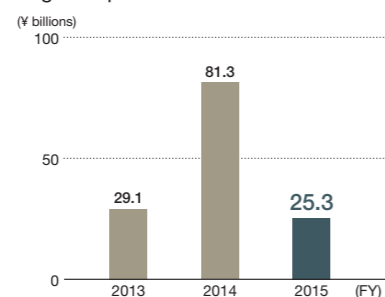
- Electrolytic nickel production is scheduled for 65,000 tons.
- Electrolytic copper production is scheduled for 445,000 tons.

### Net sales



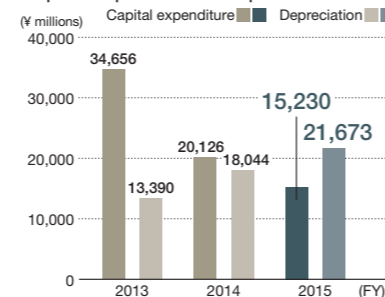
Both nickel production and sales volumes exceeded the previous fiscal year. Due to regular maintenance at the Toyo Smelter & Refinery, copper sales volume fell compared to the previous fiscal year.

### Segment profit



Due to the drop in nickel prices from the last fiscal year, profit fell to ¥25.3 billion.

### Capital expenditure / depreciation



Capital expenditures proceeded basically as planned.

### 1. HPAL (High Pressure Acid Leach) method

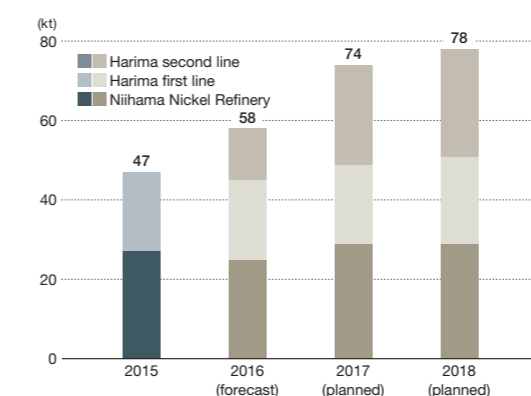
A technology to extract nickel and cobalt from low-grade nickel oxide ores. CBNC was the first in the world to succeed at large-scale commercial production in 2005; Taganito HPAL began operations in 2013 as the second production facility.

### 2. TC/RC

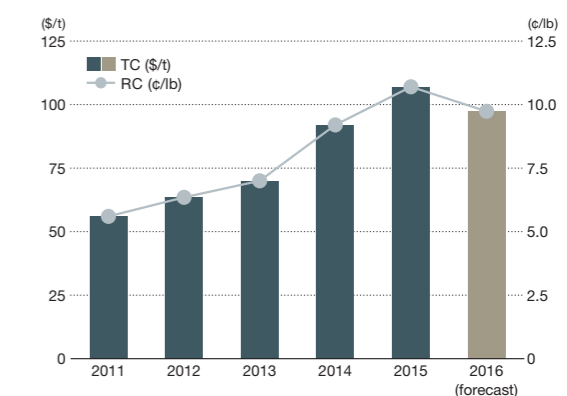
TC: Treatment Charge RC: Refining Charge

TC/RC refers to a company's margin on smelting and refining and is used for calculating the cost to smelting and refining companies when purchasing ore from mining companies. In the case of copper, for example, the fee paid to mining companies to purchase ore is the price of copper metal on the London Metal Exchange (LME) minus TC/RC (the smelting and refining margin). TC/RC are normally determined through negotiations between mining companies and smelting/refining companies, though they are also influenced by external factors such as changes in metal prices and the balance of supply and demand. Higher TC/RC rates mean lower raw material payments to mining companies, which is a favorable business environment for smelting and refining companies.

### Production volume of nickel sulfate



### TC/RC (benchmark)



### External environmental factors with a significant impact on SMM's smelting and refining business

- Increased raw ore procurement risks from a rise in resource nationalism
- More difficulty in securing raw materials due to a decline in copper ore grade and increase in processing difficulty
- A decline in profitability due to weak metal prices
- Increased demand for nickel as a material in batteries

### Core advantages of SMM's smelting and refining business

#### Use of low-grade nickel ore with HPAL technology

At CBNC in the Philippines, SMM has moved ahead of its global peers by succeeding in the commercial production of nickel intermediates from low-grade nickel oxide ore using HPAL technology. Converting low-grade nickel oxide ore into a resource allows for the efficient use of limited nickel resources and the stable supply of cost-competitive nickel raw material.

The HPAL technology successfully commercialized at CBNC in 2005 was refined through more than 10 years of operating experience and has been used in the second HPAL facility at Taganito. Furthermore, experience and know-how related to HPAL techniques are communicated to the R&D Division, which allows for multi-faceted approaches to technological development as each relevant division puts the accumulated data and knowledge to use. This process helps SMM be a front-runner in achieving advanced nickel production technology and cost competitiveness.



View of the Taganito HPAL Plant

#### Refineries with robust cost competitiveness

We have achieved world class cost competitiveness (in copper smelting and refining) at our Toyo Smelter & Refinery, our flagship smelter and refinery, through policies to improve production efficiency over more than 40 years of operations, and also in nickel smelting and refining by combining HPAL technology and the MCLE process of the Niihama Nickel Refinery. In addition, we are also striving to maximize income opportunities through stable operations.

At the same time, we are utilizing the smelting and refining technology we have built up over many years to move forward with facility automation, while also using interaction between engineers within the Group to share advanced operation technology accumulated at each business site. This allows us to maintain and elevate our technical expertise.



View of the Toyo Smelter & Refinery

#### MCLE: Matte Chlorine Leach Electrowinning

Matte Chlorine Leach Electrowinning (MCLE) is the technology used in the manufacturing process at SMM's nickel refinery. The nickel matte and MS are dissolved in chlorine to produce high-grade nickel from the nickel chloride solution using direct electrolysis of the metal. MCLE is competitive in cost terms, but poses significant operational challenges, and only two producers in the world besides SMM have commercialized it, using similar technology.

#### Co-existence with local communities

While carrying out dialogue with stakeholders, we listen to the needs and concerns of local communities, and work in harmony with these groups as we strive to operate our smelters and refineries and stably supply our products.

By processing mine wastewater, reducing dust, and safely storing residues generated in various processes, we are striving for environmental preservation through responsible environmental management.



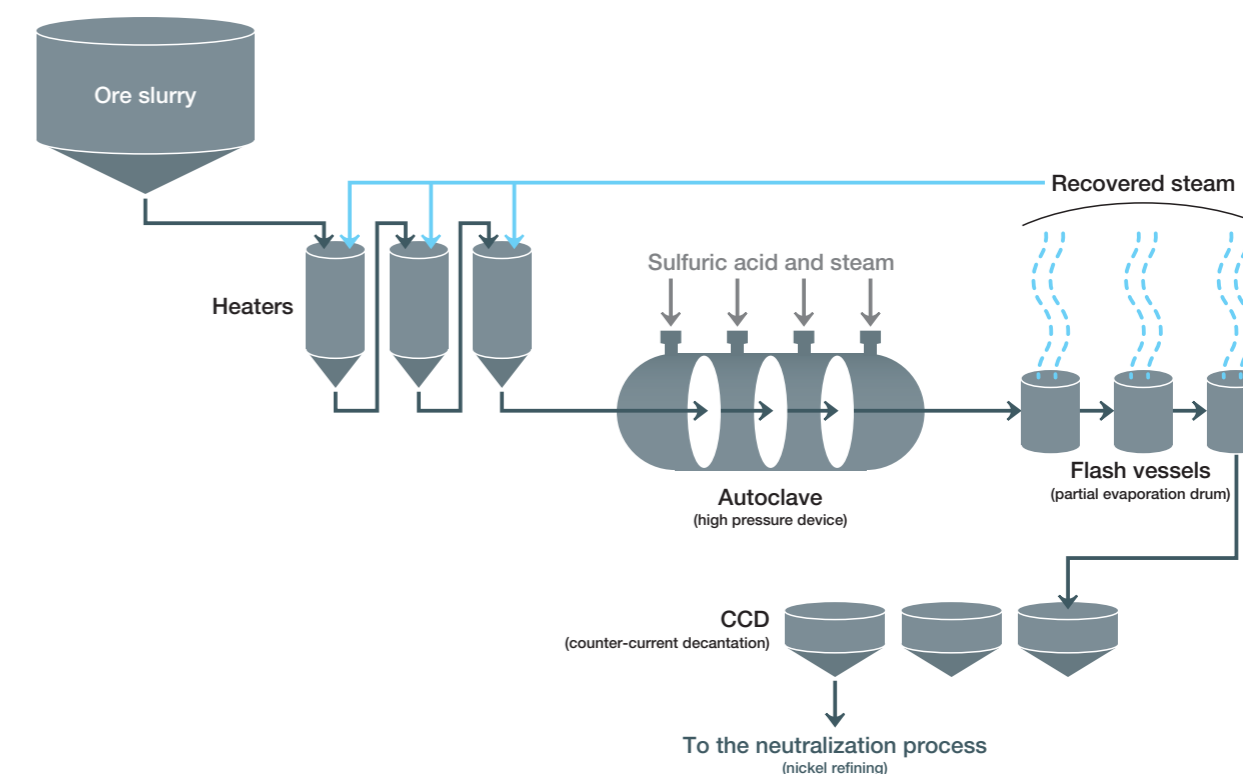
Free health exams for local communities carried out through collaboration between NAC and CBNC

### SMM Group refineries and their main products

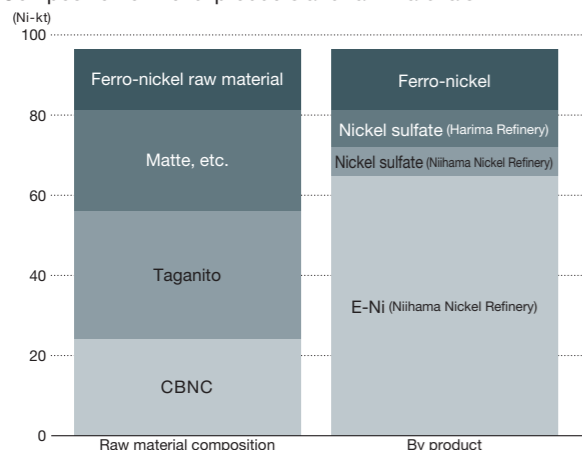
Refinery name	Products
Toyo Smelter & Refinery	Electrolytic copper
	Copper sulfate
	Slag sand
	Gold ingot, gold shot
	Silver shot
Niihama Nickel Refinery	Electrolytic nickel
	Electrolytic cobalt
	Nickel sulfate
	Nickel chloride
Harima Refinery	Nickel sulfate
Hyuga Smelting Co., Ltd.	Ferronickel shot
	Green sand
Shisaka Smelting Co., Ltd.	Zinc oxide pellet
	Iron containing pellet
CBNC	MS (mixed nickel-cobalt sulfides)
THPAL	MS (mixed nickel-cobalt sulfides)
Jinlong Copper Co., Ltd.	Electrolytic copper



#### HPAL process



#### 2015 3-Yr Business Plan Composition of nickel products and raw materials



# Materials Business

A wide range of metals is used in the manufacture of electronic devices. Copper, for example, is a critical input for electric circuitry manufacture, while nickel is used in the production of battery materials and capacitors. SMM has been engaged in the materials business since the 1960s and is supplying metals as advanced materials by leveraging its accumulated technologies.

**Toru Iijima**  
 Managing Executive Officer  
 General Manager,  
 Materials Div.



## Review of the 2012 3-Year Business Plan

### Continuous restructuring

#### ● Making selections with the objective of bringing all businesses into the black

SMM withdrew from businesses and products for which it is difficult to envision clear prospects for future development. The main businesses and products that we withdrew from during the 2012 3-Yr Business Plan were sapphire substrates, COF, ITO, metal injection molding, and GaP.

#### ● Clarifying and strengthening areas of concentration

After specifying energy/environment, information communications, and electronics/automotive as areas of concentration, we undertook fortification, including large-scale investment. In particular, we positioned battery materials and crystal materials as areas for focused growth, and therefore actively channeled investment into them.

#### ◆ Battery materials (energy/environment)

In 2014, we established an 850-ton/month production framework for lithium nickel oxide (NCA) and by launching Sumiko Energy Materials Co., Ltd. (SEM) and the Naraha Plant in Fukushima Prefecture we are moving forward with expanding production with a goal of 1,850 tons/month. We also partially started mass production of ternary cathode materials (NMC).

#### ◆ Crystal materials (information communications)

Sapphire substrates had been a focus product in our 2012 3-Year Business Plan; however, we decided to withdraw from the business due to reasons including delays in reducing costs. After withdrawing, we began capital investment in LT/LN crystal substrate production in the growing field of information communications. The investment is aimed at expanding production from 120,000 substrates/month to 400,000 substrates/month.



## Business strategy in the 2015 3-Year Business Plan

### Achieving our segment profit target of ¥20 billion

Through restructuring, including organizational changes, and by concentrating resources in strategic growth areas, we are proceeding with a host of policies to achieve ¥20 billion in segment profit in FY2018.

### Further growth in areas selected for concentration

#### ● Battery materials

We will establish a 2,550-ton/month production framework for NCA. We will move forward with expanding production of NMC, which is forecast to see rapid growth in demand.

#### ● Crystal materials

We will establish a 400,000-substrate/month production framework for LT/LN crystal substrates.

#### ● Strengthening capability to develop new business

We will proceed with building a structure for continually generating new business and a flow of new products through an integrated management process extending from searching for new products to mass production and product lifecycle management, taking into consideration a business environment with product lifecycles that are comparatively shorter than in the mineral resources and smelting and refining businesses.

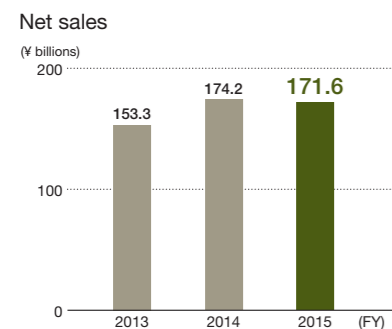
## FY2015 review and FY2016 outlook

### FY2015 review

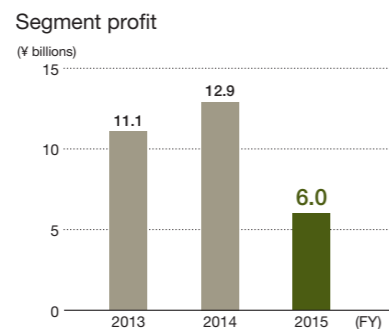
- We continued to produce nickel hydroxide at full capacity.
- We established Sumiko Energy Materials Co., Ltd. to accommodate greater production of NCA and built a new production site in Naraha Town in Fukushima Prefecture.
- We carried out capital investment toward expanding LT/LN production by 300,000 substrates/month.

### FY2016 outlook

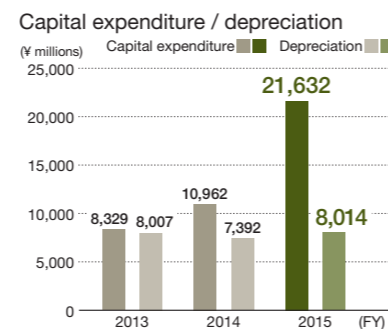
- We will move ahead toward establishing a 1,850-ton/month production capacity for NCA.
- We will move ahead toward establishing a 400,000-substrate/month production capacity for LT/LN.



Demand for materials used in automobile batteries and smartphones was robust; however, customers increasingly adjusted inventory levels for other products, which brought a slight year-on-year reduction in net sales.



Increased expenses and other charges related to expanding our production framework for materials used in automobile batteries and smartphones led to a reduction in segment profit.



Capital expenditure increased due to investment in building out our production framework for materials for automobile batteries and smartphones.

## Pivotal products for growing our materials business

### Cathode materials for vehicle batteries

NCA is used for cathodes in electric vehicle batteries, because its characteristics contribute to increased battery capacity and greater driving range on a single charge.

We are also producing nickel hydroxide and NMC for cathodes in hybrid vehicle batteries.



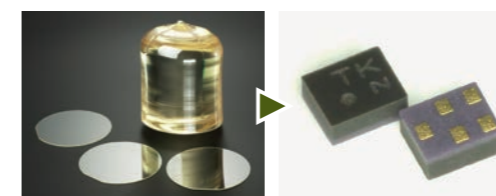
NCA

Nickel Hydroxide

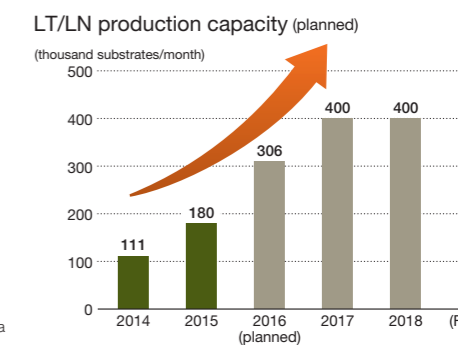
### LT/LN substrates for SAW (Surface Acoustic Wave) filters

The greatest use for lithium tantalate (LT) and lithium niobate (LN) substrates is in SAW devices. SAW devices help prevent noise and interference for smartphones and other mobile communication devices.

SMM products are recognized for the superiority of their crystal technology and processing technology.



SAW filter  
 (photo courtesy of Murata Manufacturing Co., Ltd.)



### External environmental factors with a significant impact on SMM's materials business

- Short product lifecycles compared to the mineral resources and smelting and refining businesses
- Growing interest in where raw materials originate
- Market expansion in the fields of environment, energy, and information communications

### Core advantages of SMM's materials business

#### Rolling out products leveraging core technologies

SMM is building a profitable product portfolio leveraging its core technologies, while dedicating effort to products in fields with growing demand—fields related to the environment and energy, as well as information communications.

Since products in the materials business are comparatively diverse in relation to those in the mineral resources and smelting and refining businesses, and since they also have shorter product lifecycles, we are constantly called upon to select and concentrate our business areas. As a result, the SMM Group does not formulate strategies on a product-by-product basis, but rather considers how each product fits into the overarching strategy for the materials business. We then carry out decision-making by business domain.

This system for decision-making allows us to select and finalize projects and scales that correspond to market movements, thereby achieving growth for the materials business overall.

#### Relationships with market-leading customers

We take information provided by customers and reflect it in quality improvements of products in order to help produce even better products.

Since we develop products in collaboration with customer R&D teams from the R&D stage, we are able to supply products that meet customer needs and offer a high level of reliability.

Additionally, close ties with the smelting and refining business allow us to secure a stable supply of products suited to customer needs, which is something we leverage to differentiate SMM from other companies.

#### Co-existence with local communities

Working from the SMM Group Corporate Philosophy of co-existence with local communities, we have maintained a high level of local hiring and employment. We are moving forward with restructuring and striving to maintain employment levels by striking a balance between how we secure profitability for the materials business, and how we shift to growth products inside our production bases while adopting new business projects.

### Transitioning from semiconductor materials to advanced materials

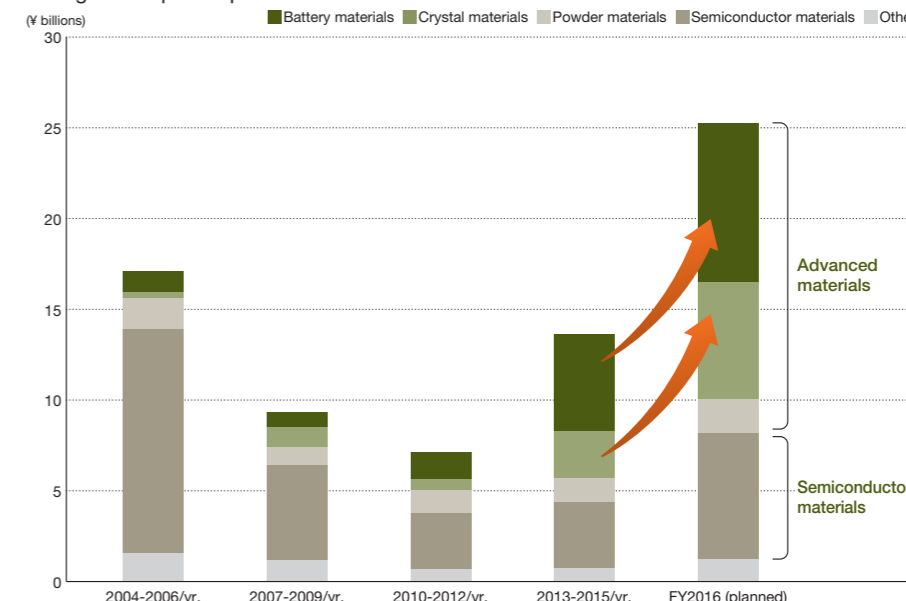
From the 2003 3-Yr Business Plan to the 2006 3-Yr Business Plan (FY2004-2009), we sought to grow business and boost our market share for individual products, while channeling capital expenditures mainly into the semiconductor materials business, which included, for example, lead frames for the general use market and copper-clad polyimide film substrates.

From the 2009 3-Yr Business Plan (FY2010), however, we carried out active and concentrated investment in cathode materials used in secondary batteries in automobiles, and crystal

materials for SAW filters used in smartphones, which are well positioned in the advanced materials business.

The result has been a transition in our business mix as we have endeavored to build solid relationships of trust with our customers, whom we treat as partners. We will continue developing next-generation products and strategically deploying capital expenditures by further strengthening these customer relationships and by utilizing management systems that generate and enhance our new products.

Changes in capital expenditures related to the materials business



Investment amounts are calculated as single-fiscal year averages from the three-year totals of actual materials-related investments in each 3-Yr Business Plan. FY2016 investment is a projected amount.

### SMM products in daily life



### Nickel-related supply chain

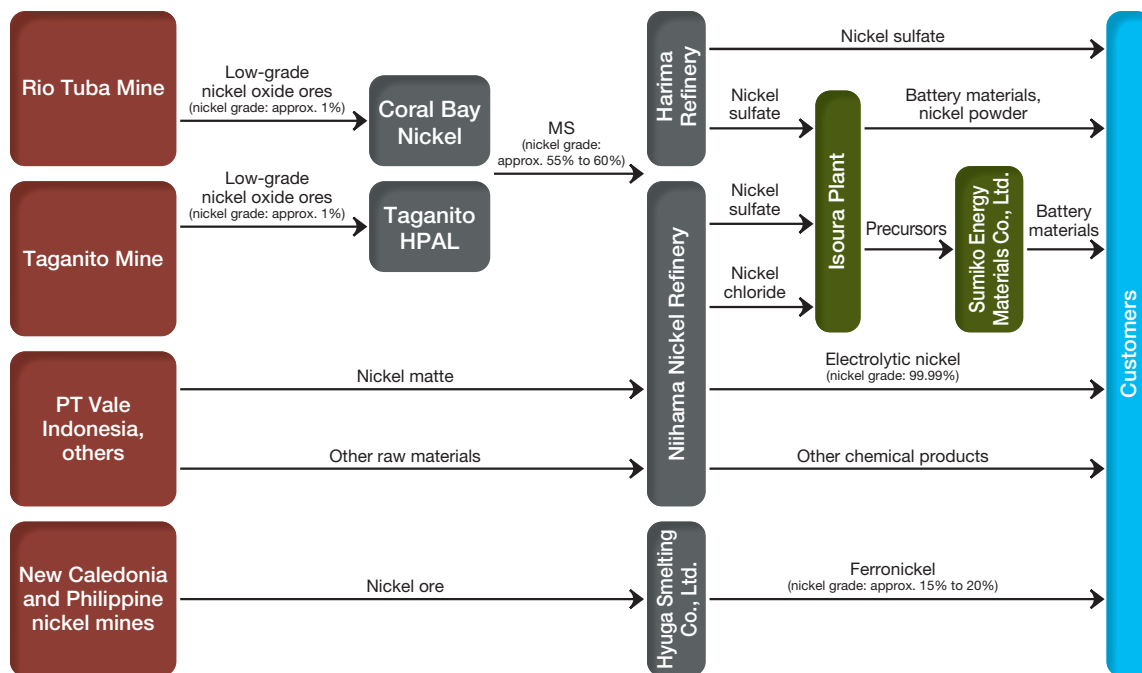
SMM produces electrolytic nickel, nickel chemical products, and ferronickel. Electrolytic nickel, nickel sulfate, nickel chloride, and other products are produced at our Niihama Nickel Refinery. Nickel sulfate is also produced at the Harima Refinery, while ferronickel is produced by Hyuga Smelting Co., Ltd.

The principal raw material for electrolytic nickel and nickel chemical products is MS (nickel-cobalt mixed sulfide) produced by Coral Bay Nickel Corporation and Taganito HPAL Nickel Corporation. The Niihama Nickel Refinery uses MS, which has an

ore grade of 55% to 60%, as well as nickel matte and other raw materials to produce 99.99% grade electrolytic nickel and other chemical products. In addition, the Harima Refinery produces nickel sulfate from MS.

At the Isoura Plant, nickel sulfate produced at the Harima Refinery and the Niihama Nickel Refinery is used as raw material for producing battery materials. Additionally, precursors (nickel compounds) made at the Isoura Plant are used to produce battery materials at Sumiko Energy Materials Co., Ltd. as well.

The nickel supply chain



### Topics Responding to the growth of the secondary battery market

#### Launching operations at Sumiko Energy Materials Co., Ltd.'s Naraha Plant

In 2014, having adopted plans to boost NCA production capacity, we were exploring ways to quickly establish a production framework to fulfill our directive to address the rapid growth in the secondary battery market.

Our solution was to lease a building from Nihon Kagaku Sangyo Co., Ltd., our partner in the town of Naraha (Futaba County, Fukushima Prefecture), to expedite the typical 20 months it takes to start up new operations to a bit more than a year, with Sumiko Energy Materials Co., Ltd.'s Naraha Plant getting off the ground in April 2016. At present, the plant's 64 employees are hard at work building a framework for full operation.

Naraha was one of the towns where the entire population was forced to evacuate due to the Great

East Japan Earthquake and the subsequent accident at the Fukushima Daiichi Nuclear Power Plant. Evacuation orders were lifted in September 2015, though many challenges still remain for residents to be able to come home. One of those challenges is employment. Since many companies withdrew from the area after the earthquake, the SMM Group hopes to use Sumiko Energy Materials to provide employment opportunities for local residents, while also doing business with local companies for materials procurement and the like. Though the scale is small, we hope that this will serve as a contribution toward solving the area's challenges.

A product briefing held during Prime Minister Shinzo Abe's visit to Sumiko Energy Materials Co., Ltd. (March 5, 2016)

Inside the Naraha Plant





**Harumasa Kurokawa**  
 Managing Executive Officer  
 General Manager,  
 Technology Div.

# Research & Development

## Research & development strategy

Within the selection and concentration that we perform in our core businesses of mineral resources, smelting and refining, and materials, we carry out priority allocation of research and development costs, and position smelting and refining process technology, powder synthesis and surface treatment technology, crystal growth and processing technology, and exploration, mining, and mineral processing technologies as core technologies. We also consider organic resin technology, analysis technology, and computer aided engineering and analysis technology as fundamental technologies, and are carrying out focused development on clearly defined technology

domains. Specifically, we are undertaking mineral resource development and further process/technology development in the field of non-ferrous metals smelting and refining, and, in the materials field, are focusing on materials and new technology development in the environment/energy fields and the information and communications fields, where great societal need exists. We perform research and development after clearly defining the scale of our sales targets for new products, an approach that is generating results. We are also undertaking basic research on powder materials in order to acquire new technologies in this area with an eye toward the future.

### Research and development by the SMM Group

#### Fundamental technology

##### Organic resin technology

Synthesis technology and selection of optimal resins for the coating, adhering, surface treatment, etc. of the various advanced materials

#### Fundamental technology

##### Analysis technology

Technology to elucidate the mechanisms behind the manifestation of performance, occurrence of faults, etc.

#### Fundamental technology

##### Computer aided engineering and analysis technology

Facility design based on fluid analysis, thermodynamic analysis, and other simulations, and material design technology based on first-principles calculations

#### Core technology

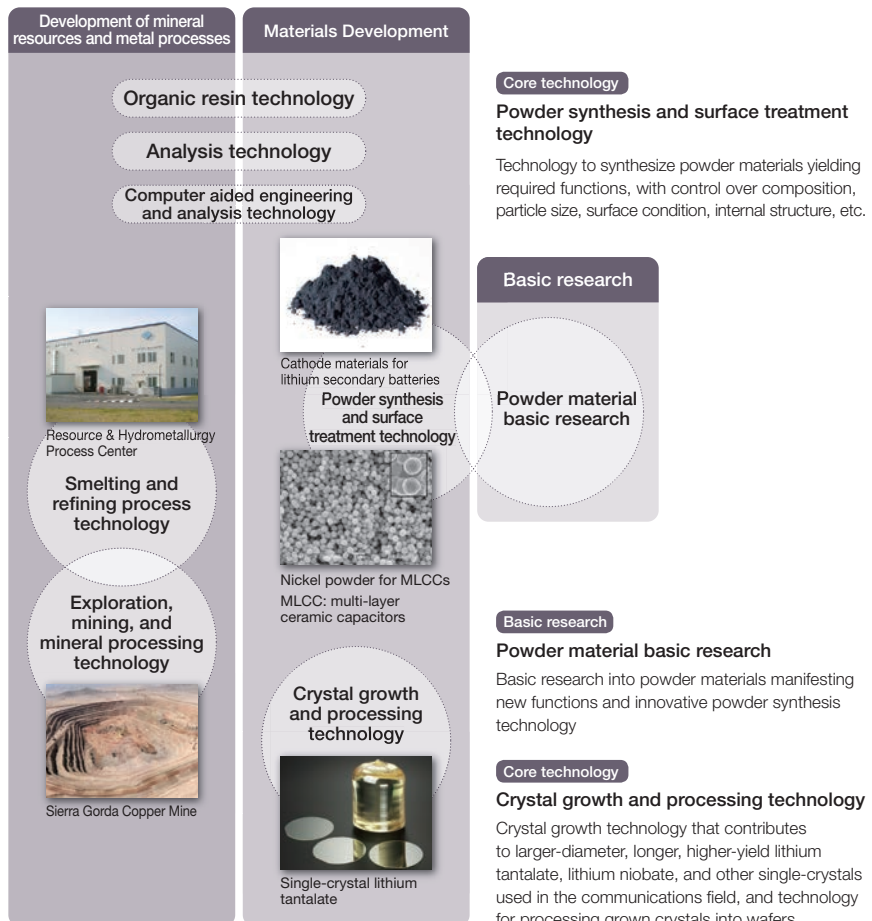
##### Smelting and refining process technology

Technology to separate and refine copper, precious metals, nickel and other valuable metals from ore and recycled raw materials

#### Core technology

##### Exploration, mining, and mineral processing technology

Exploration technology and mineral processing technology for separating and concentrating valuable metals in ores at mine sites



## Strengthening of new product development capabilities

Sustainable growth of our business requires the strengthening of our new product development capabilities. Particularly in the materials business field, where short product life cycles prevail, we must continuously bring compelling new products to the market.

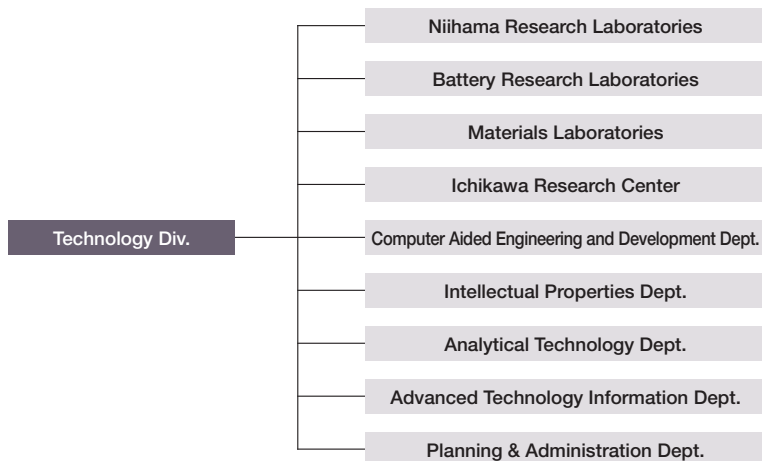
We carefully watch market and technology trends, draft research and development strategies from a long-term

perspective that takes product life cycles and the emergence of innovative technologies into account, and engage in selection and concentration of research and development themes. We will focus our efforts on not only the development themes that lie before us but also on basic research in the powder materials field.



## Research &amp; Development

## Research and development structure



The Technology Div., which is the SMM Group's R&D organization, has five departments, three laboratories, and a research center. The departments support the activities of the research center and laboratories making R&D activities for new products and technologies more efficient.

## Research and development sites and functions of each of the departments

**Niihama Research Laboratories**

The Niihama Research Laboratories aims to further raise the level of smelting and refining technologies, which are the foundation of our technology, working to further develop the potential abilities of non-ferrous metals. Specifically, the site is engaged in the development of new smelting processes and ore dressing technologies based on smelting technologies, as well as the development of powder materials and other metallic materials. In addition, the Resource & Hydrometallurgy Process Center is undertaking pilot-scale demonstration testing of a new nickel refining process.

**Computer Aided Engineering and Development Dept.**

- Engineering based on computer simulation
- Material design based on first-principles calculation

**Intellectual Properties Dept.**

- Construction of a patent network for development results
- Monitoring of patents related to company-wide research and development themes, and support for development through analysis of patent information

**Battery Research Laboratories**

In order to accelerate the expansion of our secondary battery business, which is expected to grow substantially, the Battery Research Laboratories work toward commercializing nickel-based and ternary lithium-ion battery cathode materials, which are core products, while also working on basic research based on our long-term vision for next-generation battery materials and the establishment of battery assessment technologies. At the same time, the Laboratories also proceed with research and development of fundamental technologies for battery materials.

**Analytical Technology Dept.**

- Situational observation and elucidation of mechanisms using the latest analytical instruments
- Development of new analytical methods

**Advanced Technology Information Dept.**

- Discovery and planning of new research themes

**Materials Laboratories**

The Materials Laboratories brings together engineers and works to accelerate the speed of research and development, in order to advance research and development into both crystal materials, which are related to products of the Materials Division, and into organic resins, a fundamental technology.

**Ichikawa Research Center**

The Ichikawa Research Center performs the function of sowing the seeds for future materials development. It is specialized in basic research, with a focus on functional powders.

