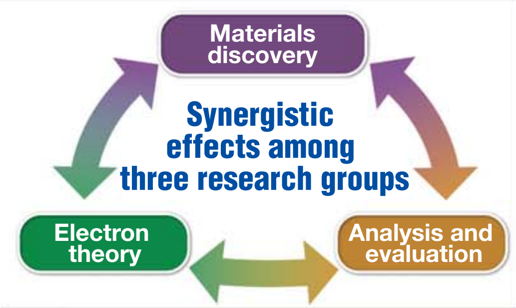
Achievements

of the MEXT Element Strategy Initiative : To Form Core Research Centers

Progressing steadily from the formulation of scientific principles to the trial manufacture of functional materials, we link scientific outcomes to industrial applications and social implementation

- A system of four research centers directly involved in strengthening Japan's competitiveness in 5 key industries (chemical, transportation, electrical, machinery, and metal)
- Engaging all efforts of industry, academia, and government: trust and expectations from the industrial sector
- Future generation human resource development and long-term strategies

Research system



Taking full advantage of large-scale, cutting-edge research facilities

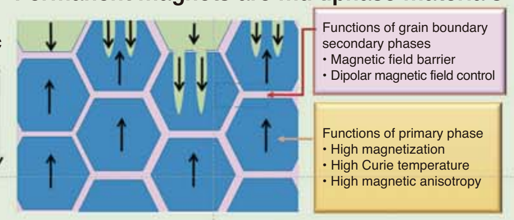
SPring-8 J-PARC Fugaku (K-computer)

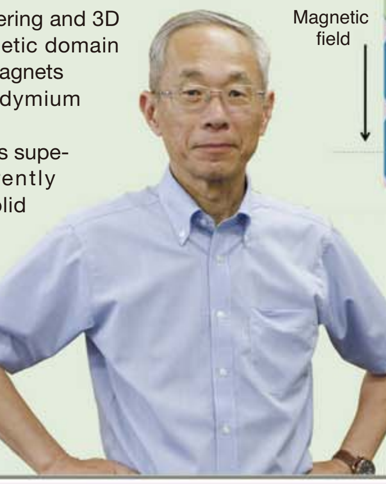
Elements Strategy Initiative Center for Magnetic Materials (ESICMM, NIMS)

Development of ultimate magnet materials without critical elements

- Developed technology using neutron scattering and 3D atom probe tomography to analyze magnetic domain structures near grain boundary phases in magnets
- Succeeded in developing a Dy-free neodymium permanent magnet
- Discovered 1-12 type $Sm(Fe\text{-}Co)_{12}$ thin films superior to neodymium magnets and currently engaged in process development for a solid form
- Organized the Materials Open Platform (MOP) on which a database of multi-component thermodynamic calculations has been created to enhance collaboration between industry and academia

Permanent magnets are multiphase materials





Structural refinement and magnetic control at the grain boundary phases is fundamental to magnet performance!

Director General
Satoshi Hirosawa

Tokodai Institute for Element Strategy (TIES)

Developing electronic materials from abundant elements that can withstand practical use

- Constructed the Materials Research Center for Element Strategy (2012)
- Iron-based superconductors: Identified the roles of hydride ions H- and applied them to superconductive magnets
- Semiconductors: Developed electron transport material of ZSO ($ZnO\text{-}SiO_2$) for a perovskite LED that achieves high-efficiency and luminance (500 times that of a smartphone)
- Discovered the first p-type transparent amorphous semiconductor Cu-Sn-I with electron mobility comparable to n-type IGZO
- Electrides: Developed intermetallic electrides such as LaNiSi as catalysts for low-temperature ammonia synthesis and established a venture company

Materials Research Center for Element Strategy

Extracting functions for tracking electron movements!

Representative
Hideo Hosono

Collaboration among centers
Synergistic effects

Elements Strategy Initiative for Catalysts and Batteries (ESICB, Kyoto University)

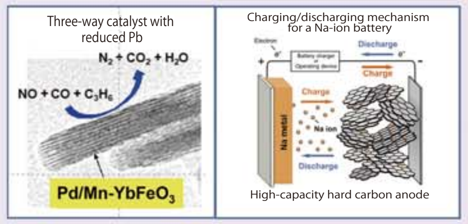
Developing a three-way catalyst for exhaust gas that is free of precious metals and inventing a high-performance Na battery system

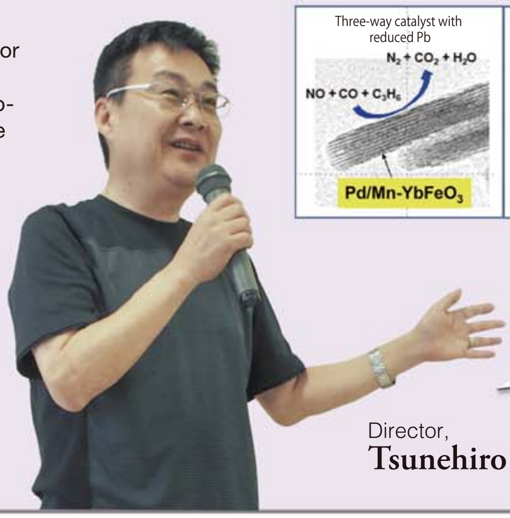
Catalysts

- Elucidated the metal-support interaction and anchor effect to design a high-performance catalyst
- Developed a tandem metal oxide three-way automotive catalyst (Zn, Cr, and Cu) free of noble metals (Rh, Pd, and Pt)
- Developed two-dimensional Rh thin film and single atom alloy (Cu_9Pd_1) automotive catalysts using less noble metals

Batteries

- Developed flame-retardant high-performance electrolytes for manufacturing a safe Li-ion battery prototype exhibiting long life
- Developed a new method of synthesizing high-capacity hard carbon (anode material) for manufacture of Na-ion batteries





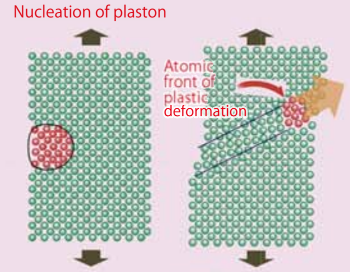
Interface control is the determining factor in both catalysts and batteries that enables us to achieve high performance without rare elements and noble metals!

Director,
Tsunehiro Tanaka

Elements Strategy Initiative for Structural Materials (ESISM, Kyoto University)

Formulating scientific principles and discovering innovative materials that achieve both strength and ductility in structural metals

- Proposed a new concept on the elementary process of plastic deformation in structural materials called "plaston," which is the collective excitation of atoms in a singular stress field
  Formulated scientific principles for achieving a balance of strength and ductility in metal materials while suppressing fatigue failure, paving the way to innovative materials
- Discovered bulk nanostructured materials having plaston-induced ductility: titanium and magnesium alloys, steel materials, etc.
- Elucidated the mechanism of plastic deformation in brittle materials and acquired guidelines for developing practical automotive materials such as galvannealed (GA) steel sheets
- Developed software and a database for calculating lattice vibrations, which are used throughout the world as the de facto standard



Pursuing tougher structural materials for a safe and secure society!

Director
Isao Tanaka