#### Element Strategy Initiative International Advisory Council (ESIAC) 2019



# Elements Strategy Initiative for Structural Materials ESISM





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## Strength is important





# Ductility is essential



Formability





Earthquake disaster@Kobe 1995

Shock absorption : Strength x Elongation (Ductility)

Essential for safe and secure society.

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## **Dislocation mechanism in metals**



## **Ductility increases**

by **enhanced** movement and multiplication of dislocations

## **Strength increases**

by **retarded** movement and multiplication of dislocations



solution hardening precipitation hardening

# Origin of the trade-off relationship.

#### **Bulk Nano-structured Materials (BNM)**



**BNM** has recent focus due to discovery of unique properties.

## **Bulk Nano-structured Materials (BNM)**

#### Four times enhancement of strength.



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#### **Bulk Nano-structured Materials (BNM)**





# **Research Topics**

Topic 1. Plaston concept



Topic 2. Realization of *plaston* induced plasticity materials

Topic 3. *Plaston* in brittle materials



Topic 4. Atomic process of plaston

by first principles and atomic simulations



Ikuhara

**Topic 5. Novel experimental techniques** 



to analyze *plaston* processes



#### The plaston concept

#### **Plaston:** Atomic origin of plastic deformation in general.





## Atomic process of plaston : Simulation



## Plaston process by advanced beam sources



# Newly discovered enhanced plasticity in BNM

Material	Plaston mechanism for enhanced plasticity	Maximum elongation in BNM	Discovery year	Ultra fine
Mg alloy	unusual dislocation + deformation twin	0.26	2018	grained metal ↓ Deformation
Cu alloy	deformation twin	0.43	2016	
Austenitic steel	martensitic transformation	1.0	2016	• σ
High Mn steel	deformation twin	0.55	2019	Plaston nucleation @ grain boundary
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## **Achievements: Summary**

#### **Intellectual Merit**

- Establishment of the new concept of *plaston* through collaboration of fundamental studies.
- ✓ Realization of new plaston induced plasticity materials.

#### **Broader Impacts**

- ✓ Development of new computational/experimental tools useful for materials science in general.
- Transfer of ideas from fundamental research to industry.
- ✓ Nurture of **talented researchers**.