15 years of Tsai lab
- From the eyes of a staff member -

Nobuhisa Fujita

IMRAM, Tohoku University,
Sendai 980-8577, Japan
Prof. A.P. Tsai (my personal view)

- He was neither a physicist nor chemist, but metallurgist.
- He was an experimentalist by his nature, and one of the best experimentalists I’ve ever met.
- He was keen on something new & unexpected and on being a pioneer, but remained objective in thinking.
- He was humble and open minded in listening to his young colleagues & students.
- He allowed the lab members to have a lot of freedom and offered generous support for research.
- He was frank and honest when talking.
15-year chronology: members

Visiting scientists:
Prof. T. Janssen, Prof. P. Thiel, Prof. D. Shechtman, Prof. M. deBoissieu, Prof. E. Belin-Ferre, Prof. J.M. Dubois, Prof. K. Chattopadhyay, Prof. S.F. Wang, Prof. H.R. Sharma, Dr. C. Cui, Dr. G.H. Gebresenbut Prof. S. Suzuki, Prof. H.R. Trebin, Dr. M. Mihalkovic, Prof. L.S. Hong
Staff members: combination of different disciplines (*experimental* !)

Prof. A.P. Tsai

Metallurgy

Dr. S. Kameoka

Catalyst chemistry

Dr. N. Fujita

Condensed matter physics (theory)

Dr. S. Ohhashi

Technical staff:
Synthesis of alloys,
SEM, TEM

Dr. T. Kojima

Solid state catalysts,
Magnetic materials,
Metallic thin films
Research activities

Effects of alloying on structure & properties


Cd-Yb iQC & approximants Structure modeling (CPG)
Mg-Zn-Y high-strength alloys
QCs as catalyst precursors
Pseudoelements for catalysis: PdZn(≈Cu), CuNi(≈Pd), NiZn, PtZn
Spinel CuFe$_2$O$_4$ as a catalyst precursor

Cd-Mg-Yb, Cd-Mg-Ca high-strength alloys (SO)
Microstructure design for better catalysts
Catalysts for Carbon nanofibers
Fabrication of fine porous Au catalysts through leaching
Fabrication of alloy catalysts through hydrogenation

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2019/7/5  QSC2019, Memorial session for Prof. Tsai (Sendai, 25 June 2019)
Clusters packing geometry in i-QC and approximants (NF)

We have renewed the way to understand the structure of Al-based F-type iQC & approximants as a packing of two kinds of small cluster centered at the nodes of a canonical-cell tiling.

Application of quasicrystals for reinforced Mg alloys (SO)

Single QC growth | Microstructure containing QC | Orientation relationships

QC-reinforced Mg alloys: Zn-Mg-Zr Qc, Mg-Cd-Yb Qc in Mg

Designing new catalysts through the fusion of metallurgy & catalyst chem.

**Metallurgy (AP Tsai)**
Knowledge about crystal structures, surfaces & microstructures

**Catalyst chem (S Kameoka)**
Knowledge about adsorption states & catalytic reactions

*Aim: to find new (unexpected) routes to efficient catalysts.*

# Tuning the electronic structure and/or microstructure
# New understanding on the generation of active sites
Tuning the electronic structure for catalysis
(Pseudoelement: PdZn ≈ Cu for SRM)

CO₂ selectivity of steam reforming of methanol and valence electronic structures for PdZn, Cu and Pd

Tuning microstructures through eutectic reaction + leaching

**Eutectic microstructure (Lamellar) with porous Au (or Pt) layers**

Fe$_3$O$_4$: CO + H$_2$O $\rightarrow$ CO$_2$ + H$_2$ (exothermal)

Pt: CH$_3$OH $\rightarrow$ CO + 2H$_2$ (endothermal)

Overall CH$_3$OH + H$_2$O $\rightarrow$ CO$_2$ + 3H$_2$ (endothermal)


Creation of catalytic active sites at microscopic twin boundaries

**PG(Ag₃Au)** with **cHNO₃**

**PG(Al₂Au)** with **NaOHaq.**

Twin boundary (TB) defects in the fcc lattice of bulk gold can create close-packed rows of low-coordinated atoms (W-chains; CN= 5 or 6) as active sites on the stepped {211} surfaces of bulk Au.

## Education & honors

### (Number of admitted graduate students)

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### Degrees
- **Ph.D.**
- **Master**
- **Doctor**

### Honors
- **1st Jean-Marie Dubois Award**
- **Honda Frontier Award**
- **Honorary Doctorate at Institute of National Polytechnique de Lorraine**
- **Masumoto Hakaruu Award (JIM)**
- **Honor Medal with Purple Ribbon**
- **Distinguished Professor (Tohoku Univ)**
- **Honorary member (Academia Sinica)**
- **Prof. Shechtman’s Nobel prize in chemistry**