

On the Scheme for International Collaborative Research + Functional Oxide Materials

Hisao Yamauchi

Finland Distinguished Professor
@
Department of Chemistry
Helsinki University of Technology
FINLAND



Name : Hisao YAMAUCHI (山内 尚雄)

Birth: 26 October 1946; Wakayama, Japan

Education :

University of Tokyo: B. Eng.
in **Applied Physics** (1969)

Northwestern University: M. S.
in **Materials Science** (1971)

Northwestern University: Ph. D.
in **Materials Science** (1973)

Research and Professional Experiences:

1969-73: Research Assistant,
Northwestern University (IL, USA)

1973-74: Postdoctoral Fellow,
University of California - L.A. (CA, USA)

1974-80: Researcher,
Central research Laboratory - Hitachi, Ltd. (Tokyo, Japan)

1978-80: Research Engineer,
University of California - L.A. and - Berkeley (CA, USA)

1980-84: Associate Professor of Engineering Materials,
University of Windsor (ON, Canada)

1984-91: Professor of Engineering Materials (tenured)
University of Windsor (ON, Canada)

1988-94: Division Director, Superconductivity Research Laboratory,
International Superconductivity Technology Center (Japan)

1995-09: **Professor of Functional Ceramic Materials**
Tokyo Institute of Technology (Japan)

2009- **Finland Distinguished Professor**
Helsinki University of Technology (Finland) &
Professor Emeritus, Tokyo Institute of Technology

yamauchi@tkk.fi

Phone: +358-9-451-2602

- Scheme for Collaborative Research
- Proposed Research Field:
 - Functional **Oxide** Materials
- Comments on Material "Function"

high- T_c Superconductor

Condensed
Matter
Zeitschrift
für Physik B
© Springer-Verlag 1986

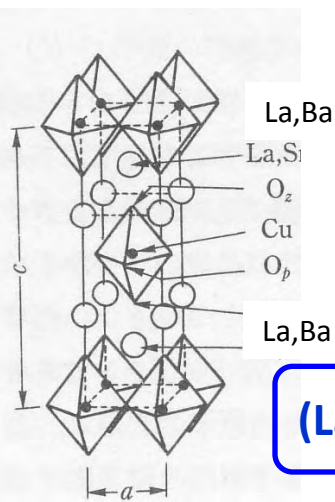
Possible High T_c Superconductivity in the Ba – La – Cu – O System

J.G. Bednorz and K.A. Müller

IBM Zürich Research Laboratory, Rüschlikon, Switzerland

Received April 17, 1986

Metallic, oxygen-deficient compounds in the Ba – La – Cu – O system, with the composition $\text{Ba}_x\text{La}_{5-x}\text{Cu}_5\text{O}_{5(3-y)}$ have been prepared in polycrystalline form. Samples with $x=1$ and 0.75 , $y>0$, annealed below 900°C under reducing conditions, consist of three phases, one of them a perovskite-like mixed-valent copper compound. Upon cooling, the samples show a linear decrease in resistivity, then an approximately logarithmic increase, interpreted as a beginning of localization. Finally an abrupt decrease by up to three orders of magnitude occurs, reminiscent of the onset of percolative superconductivity. The highest onset temperature is observed in the 30 K range. It is markedly reduced by high current densities. Thus, it results partially from the percolative nature, but possibly also from 2D superconducting fluctuations of double perovskite layers of one of the phases present.



Oxide !!

$(\text{La, Ba})_2\text{CuO}_4$

Fever !!

1987 Nobel in Phys.



ノーベル物理学賞の受賞を喜ぶミューラー博士（右）とベドノルツ博士



会場に入れない人のためにビデオカメラも入った米国物理学会の新高温超伝導シンポジウム会場＝87年3月18日、ニューヨーク・ヒルトンホテルで

APS Spring Meeting at New York Hilton
(March 18, 1987)

High T_c Superconductivity of La-Ba-Cu Oxides

Shin-ichi UCHIDA,[†] Hidenori TAKAGI,[†] Koichi KITAZAWA^{††}
and Shoji TANAKA

Department of Applied Physics, University of Tokyo, Hongo, Tokyo 113

[†]Also at Engineering Research Institute, University of Tokyo, Yayoi, Tokyo 113

^{††}Department of Industrial Chemistry, University of Tokyo, Hongo, Tokyo 113

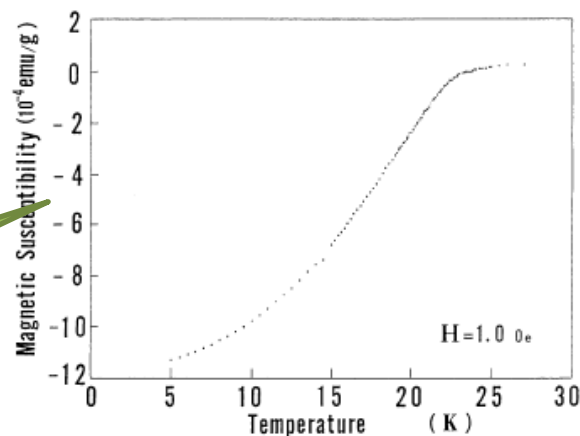


Fig. 1. Magnetic susceptibility of a sample prepared from a mixture of oxides and carbonates as a function of temperature.

HY joined ISTE
to start SRL
in 1988

1987: International Superconductivity Technology
Center: **ISTEC**

1988: Superconductivity Research Center: **SRL**



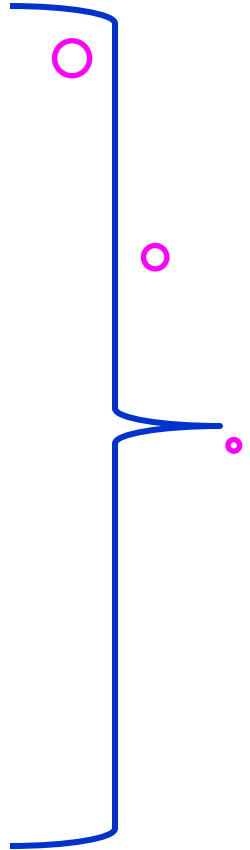
1986
Autumn
in Tokyo



Synergetic effects !?

Research of HTSC is relevant to:

1. Physics
 2. Chemistry
 3. Materials Science
 4. Metallurgy – Materials Engineering
 5. Electrical Engineering – Power & Electronics
 6. Law – Patents
 7. Economics - Industry - Business
 8. Politics
 9. Literature
- etc.*



ISTEC - Office

SRL: Prof. Tanaka, Director

SRL - Office

Div. I
Characterization

Div. II
New Materials

Div. III
Physics

Div. IV
Bulk Process

Div. V
Thin Film Tech.

Nagoya Div.
Production Tech.

HY: 1988 - 1994

Researchers from foreign countries:

- Norway
- Finland
- France x 2
- China x 2
- Poland
- Taiwan

Domestic researchers from industry:

- > 10 people all the time
- mostly M.S. without doctoral degrees

SRL: Prof. Tanaka, Director

SRL - Office

Div. I
Characterization

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New Materials

Div. III
Physics

Div. IV
Bulk Process

Div. V
Thin Film Tech.

Nagoya Div.
Production Tech.

HY: 1988 - 1994

Researchers from Foreign Countries:

- Norway – Prof. em. Kristian Fossheim
- Finland – Prof. Maarit Karppinen [STA fellow]
- France x 2 – Prof. P. Lafeiz, Dr. Wang
- China x 2 – Prof. C.Q. Jin, Prof. X. J. Wu
- Poland – Prof. R. Puzniak
- Taiwan – Prof. C. J. Liu

Researchers from Domestic Companies:

- > 10 people all the time
- mostly M.S. without doctoral degrees



- PhD x 12 (“supervised”)
- Prof. x 4

“Oxygen engineering”

“0201” HP phase

High pressure synthesis
“Cu-based homologous series”

HRTEM for HP-synthesized samples

H_{irr} and anisotropy of the then-new
Hg-based homologous series



Few tens of patents + > 300 papers

Postdocs (then)

(Prof. G. Van Tendeloo)

Prof. I. Monot

Prof. P. Lafez



Prof. M. Karppinen

Dr. J. O. Willis

Dr. J. Wong



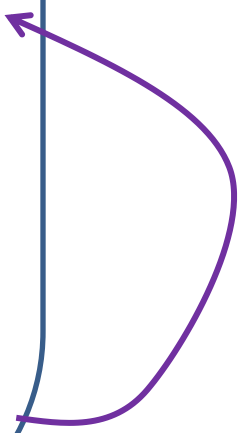
Prof. C.Q. Jin

SRL: Prof. Tanaka, Director

SRL - Office

Div. I
CharacterizationDiv. II
New MaterialsDiv. III
PhysicsDiv. IV
Bulk ProcessDiv. V
Thin Film Tech.Nagoya Div.
Production Tech.

Researchers + Staff > 120 in a single building

- All the researchers shared a single large office room/
wall-less space.
 - Active discussions between researchers semi-openly
at div. director's open partitioned space,
at open coffee (/ smoking) corners,
at lunch tables in (a neighbor-company's) cafeteria,
etc.
 - Equally independent researchers + one director in a Div.
(unlike in many Japanese teams / groups)
- 

After >20 years of HTSC: excellent synergetic effects !

-
1. Physics
 2. Chemistry
 3. Materials Science
 4. Metallurgy – Materials Engineering
 5. Electrical Engineering – Power & Electronics
 6. Law – Patents
 7. Economics - Industry - Business
 8. Politics
 9. Literature
etc.

Functional
Oxide Materials

Strongly-correlated-electron
systems

Oxide Materials

Appl. Phys. &
Mat. Science

Yamauchi's Collaboration with Karppinen

Chemistry &
Appl. Phys.

Name : Hisao YAMAUCHI (山内 尚雄)
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1995-09: Professor of Functional Ceramic Materials (tenured)
Tokyo Institute of Technology (Japan)
2009- Finland Distinguished Professor
Helsinki University of Technology (Finland) &
Professor Emeritus, Tokyo Institute of Technology

~300 papers + > 5 patents

Guest Professors:

Maarit Karppinen (Finland)

Helmer Fjellvåg (Norway)

Satish Malik (India)

Pavel Karen (Norway)

Xing Hu (China)

Postdoctoral Fellows:

Sergey Lee (Russia)

Johan Lindén (Finland)

Veerpal Awana (India)

Yunhui Huang (China)

Markus Valkeapää (Finland)

Mikko Matvejeff (Finland)

@ MSL @ Tokyo Tech

Foreign students stayed with the Yamauchi-Karppinen Group (1995 - 2008):

PhD students

4 Finnish
1 Russian
1 Lithuanian
1 Chinese
1 Taiwan

MS Students

11 Finnish
2 Chinese
1 Lithuanian

Supported by:

- Materials and Structures Laboratory (of Tokyo Tech)
 - International Collaborative Research Project Grants
- JSPS Postdoctoral Fellowship for Foreign Researchers
- Japanese Government (Monbukagakusho: MEXT) Scholarship
- Tokyo Tech's (various) Exchange Student Scholarships
(e.g. Tokyo Tech-TKK student exchange agreement)
- Scandinavia-Japan Sasakawa Foundation
- Helsinki Univ. of Tech Exchange Student Scholarship
- Self-support (Finnish students receive financial support from the government.)

June, 2001



for International Collaborative Research:

- ◆ Collaborative projects are NOT side-jobs:
 - Long-term full-time involvements of the team members are indispensable.
- ◆ Multidisciplinary members are in a team.
- ◆ Members are equally independent, (except for the leader).
- ◆ Spatial proximity among researchers is essential:
 - for free-discussions and information exchanges.
- ◆ Persistent effort in publishing all “publishable” data is of No.1 priority of the leader.
 - So is in patent application.

Reference:

NOKIA
Nokia Research Center



Nokia Research Center (NRC) - - - Our teams are **strategically located worldwide to collaborate with leading universities and research institutes** in the mode of **Open Innovation**.

- - - - Our **current research focuses on the areas** of rich context modeling, user interface, high performance mobile platforms, and cognitive radio.

- - - - There are 500 of us in NRC teams in Europe, Asia, Africa and North America. We have **a variety of personal and technical backgrounds**, but we are all researching topics related to - - - -.

Karppinen and Yamauchi are working on:

Functional *oxide* materials

KE-35.4500

Funktionaaliset oksidimateriaalit (3 op)

SCHEDULE

	Date	Topic
1. Mo	19.01.	Oxide structures, oxygen stoichiometry & mixed-valency
2. We	21.01.	Superconductive oxides
3. Mo	26.01.	Thermoelectric oxides (09 Finn-Jpn project: with I. Terasaki)
4. Mo	02.02.	Oxygen-storage and SOFC materials
5. Mo	09.02.	Transport and magnetic properties
6. We	11.02.	Li-ion battery materials
7. Mo	16.02.	Oxide halfmetals and multiferroics
8. We	18.02.	Oxides in electronics & optoelectronics
9. Mo	23.02.	Bulk and thin-film syntheses
10. We	25.02.	TiO₂
	We 04.03.	Exam, 14-17 (Ke4)

KE-35.4500

Funktionaaliset oksidimateriaalit (3 op)

SCHEDULE

	Date	Topic
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5.	Mo 09.02.	Transport and magnetic properties
6.	We 11.02.	Li-ion battery materials
7.	Mo 16.02.	Oxide halfmetals and multiferroics
8.	We 18.02.	Oxides in electronics & optoelectronics
9.	Mo 23.02.	Bulk and thin-film syntheses
10.	We 25.02.	TiO ₂
	We 04.03.	Exam, 14-17 (Ke4)

for efficient
signal processing

Proposed research field:

"Functional Oxide Materials for Spintronics",

e.g. Halfmetals, Multiferroics,

- New Material Search / Realization (Synthesis)
- Versatile Thin Film Processes
- Characterization of Halfmetallicity [phys, tkk]

Science behind iPod wins Nobel Physics prize

GMR

Two scientists who put the 'nano' in iPod Nano have been awarded a **2007 Nobel Prize**. Albert Fert of France and Peter Gruenberg of Germany discovered the **giant magnetoresistive effect**, or spintronics, simultaneously and independently in 1988. It uses the spin of the electron to store and transport information instead of the electrical charge, meaning much more information could be kept in a smaller space than before. The technology allowed the development of handheld devices such as iPod music players and mobile phones that function like little computers.

Peter **Gruenberg** (left) is a leading researcher in thin film and multilayer magnetism at the Institute for Solid State Physics at the Juelich Research Centre (Forschungszentrum Juelich), one of the largest interdisciplinary research centres in Europe.

Albert **Fert** (right) is currently professor at University Paris-Sud in Orsay and scientific director of the Unité mixte de physique CNRS/Thales.

The two men will share the 10m Swedish crown (€1.09m) Nobel Physics prize and join the prestigious ranks of Albert Einstein, Marie Curie, and Niels Bohr.

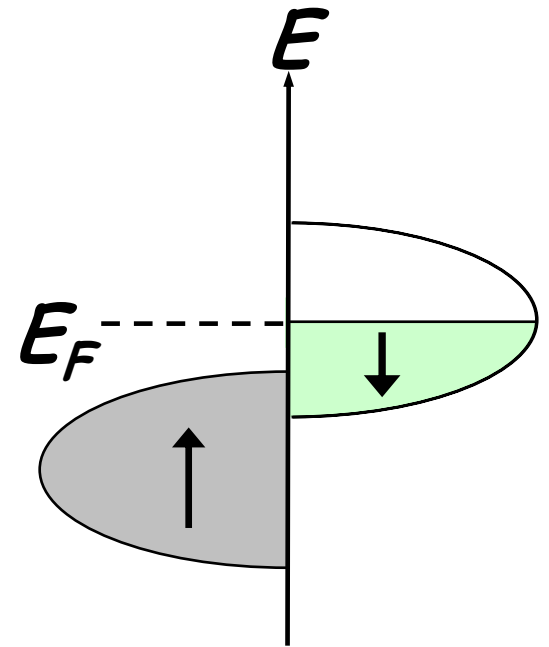
The winner of the Nobel prize for chemistry will be announced tomorrow, followed by the literature prize on Thursday and peace on Friday.

Tuesday, 9 October 2007 16:22 : <http://www.rte.ie/news/2007/1009/nobel.html>



HALFMETALS

- ferro/ferri-magnetic conductors
- **carriers 100 % spin-polarized**
- **tunneling magnetoresistance (TMR)**
- application in **SPINTRONICS**

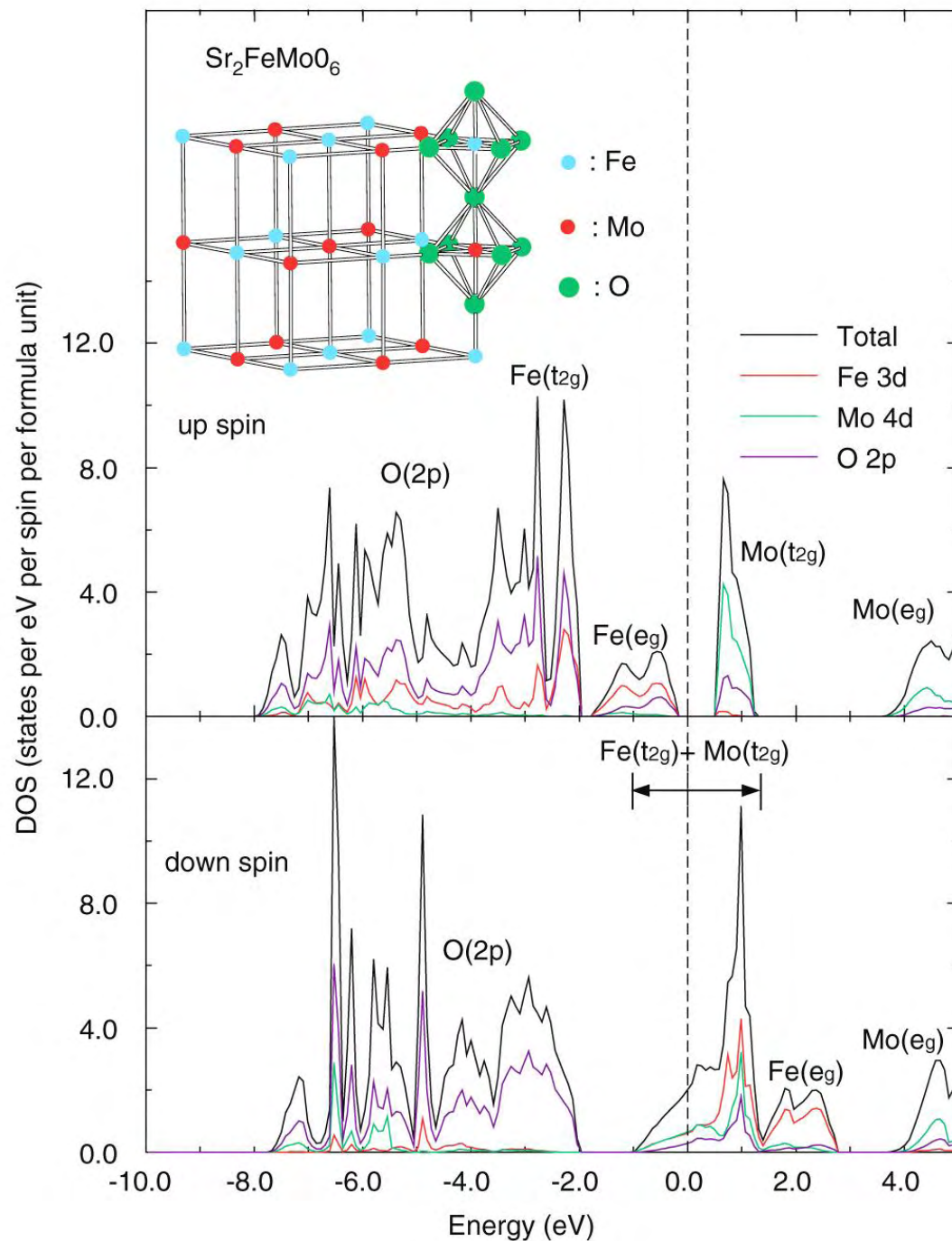
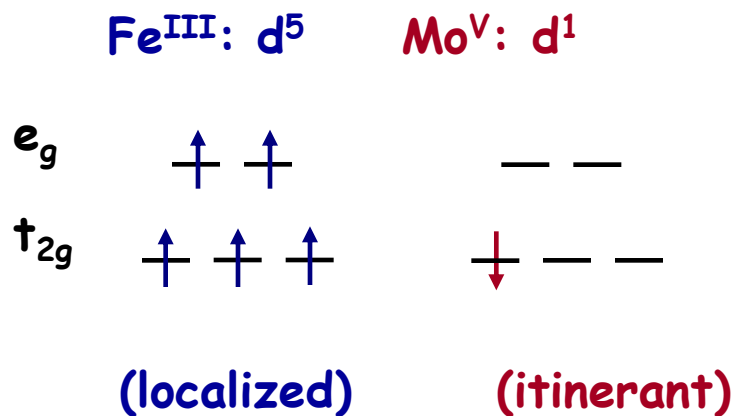


R.A. de Groot et al., Phys. Rev. Lett. 50, 2024 (1983).

- **Heusler alloys:** X_2YZ (e.g. Co_2MnSi , Co_2CrAl ,...)
half-Heusler alloys: XYZ
- **Zinc Blendes:** CrAs , MnAs
- **Oxides:** Fe_3O_4 , CrO_2 , $(\text{La}_{1-x}\text{A}_x)\text{MnO}_3$ ($x = 0.175$: CMR),
...



Kobayashi et al.,
Nature 395, 677 (1998).



Note !!

Material
= Matter

Property

∈

∈

Material
= Functional Material

Function

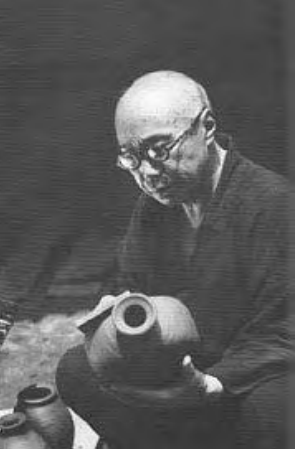
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Functional Oxide Materials

You may discover or propose novel ones if you could demonstrate them to work for:

→ e.g. **commercialization**

← **definition**: quite pragmatic, industrial, utilitarian, ..., **business-consideration**, ...



a Novel "Function"

用の美



Shoji Hamada (1894 - 1978)

1916: Graduated from **Tokyo Institute of Technology**

1920-24: Construction of Kilns for **St. Ives Pottery**
of Bernard Leach in **Cornwall, UK**

1930: **Mingei**-pottery at **Mashiko**

1955: "Living National Treasure"

Bernard Leach (1897 - 1979)

1909-1920: stayed in **Japan**

1920: setup **St. Ives Pottery**

Mingei (民藝) Movement:
since 1920's

Mingei (民藝) / Folk Crafts : Criteria defined by
Soetsu Yanagi (1889 – 1961):

- made by anonymous crafts people
- produced by hand in quantity
- inexpensive
- used by the masses
- functional in daily life
- representative of the region in which it was produced.

Artistic feature stemmed
from the main purpose
of the craft , *i.e.* being
**functional in people's
uses in daily life**

← **anti-industrial
mass production &
- aristocratic taste**

spontaneously



用の
美
yoo no bi

Alvar Aalto (1898 – 1976)

1921: Diploma in Architecture from the
Technological University of Finland

1946-1948 : Professor at Massachusetts Institute
of Technology M.I.T. (Cambridge, USA)

1963-1968: President of the Academy of Finland

"Art stemmed from functionality"

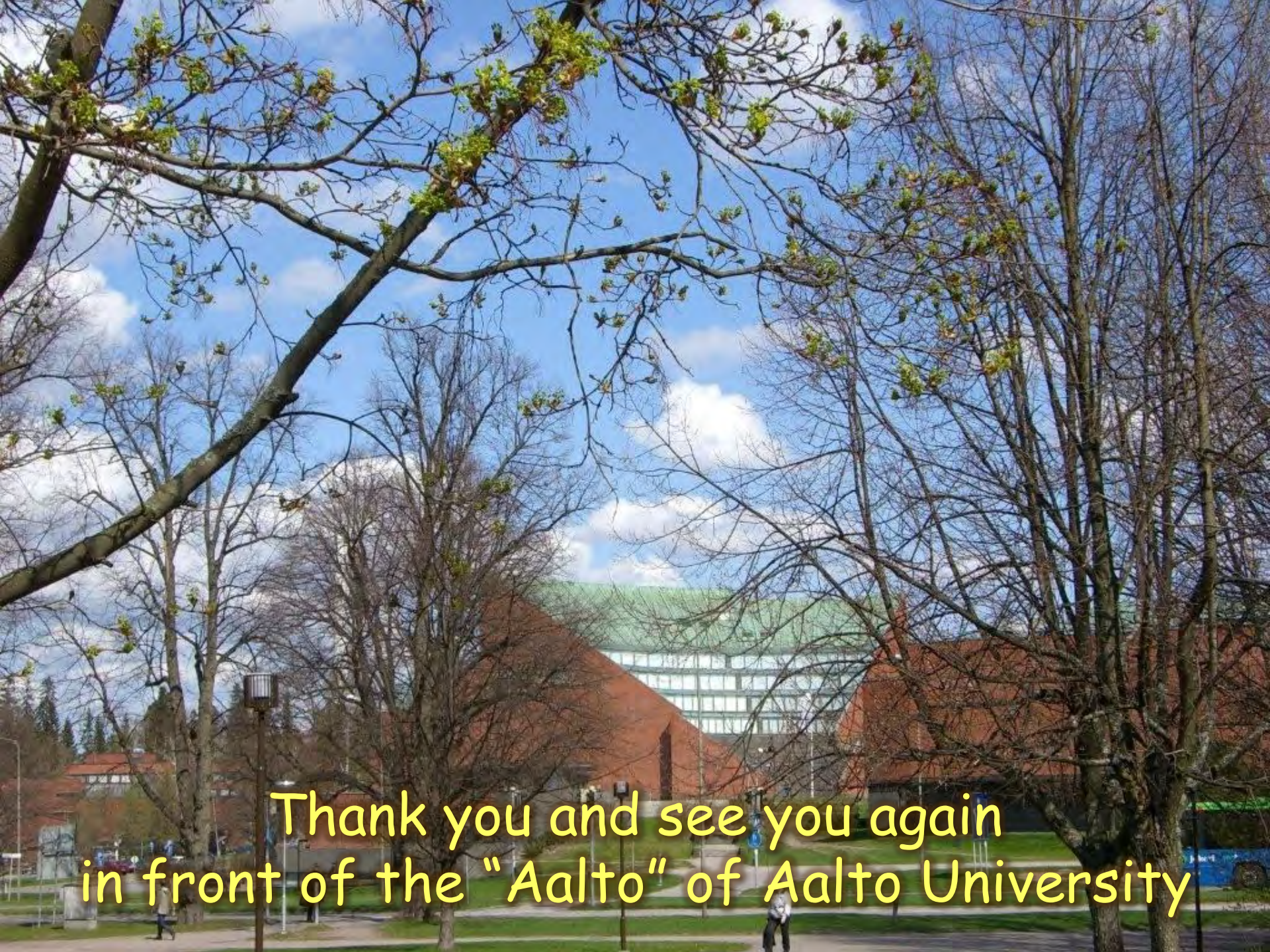
AALTO UNIVERSITY IS AN INTERNATIONALLY UNIQUE CONCEPT

The new Aalto University was created through the merger of :

- ◆ Helsinki School of Economics (HSE) ————— Industry, Business
- ◆ University of Art and Design Helsinki (TaiK) ——— Artistic Life
- ◆ Helsinki University of Technology (TKK) ————— Technology - Industry

Aalto University is creating a new **science and arts community** by bringing together three existing universities of technology, economics and art. The combination of three universities opens up new possibilities for **strong multi-disciplinary education and research**. The new university's ambitious goal is to be one of the leading institutions in the world in terms of research and education in its own specialized disciplines.

The university graduates will be individuals who maintain their **open-minded inquisitiveness throughout life**.



Thank you and see you again
in front of the "Aalto" of Aalto University