Institute for Catalysis (ICAT)
Hokkaido University
Institute for Catalysis, Hokkaido University
Founded in 1943 by Prof. Juro Horiuchi
as Institute for Catalysis
And
Remodel in 1989 to Catalysis Research Center (CRC)
reorganized in 2015 to Institute for Catalysis (ICAT)

8 Professors. 8 Associate Professors, 8 Assistant Professors

Director: Kiyotaka Asakura
Vice Director: Junya Hasegawa
Special Professors:
  Prof. E. Negishi
  Prof. A. Suzuki

Department of Fundamental Research
Catalyst Surface Research Division (K. Asakura)
Catalysis Theory Research Division (J. Hasegawa)
Catalytic Transformation Research Division (A. Fukuoka)
Catalyst Material Research Division (K. Shimizu)
Photocatalysis Research Division (B. Ohtani)
Molecular Catalyst Research Division (T. Takahashi)
Macromolecular Science Research Division (T. Nakano)

Department of Practical Application
Research and Development Division (M. Nishida)

Joint Usage and Research Center in Catalysis Field in Japan
Catalysis is a material to accelerate chemical reactions. Professors and graphical view of activity

**Biomass conversion and mesoporous materials**

- **Photo catalyst and noble TiO$_2$ synthesis**
  - Decahedral-shaped single crystalline
  - Scheme 1

**Molecular catalyst and C-C bond formation**

**Fine chemistry by heterogeneous catalysts**

- **Catalysis Theory**
  - Fig. 1 Complete oxidation of ethylene on the Pt/silica surface model.

**Advanced Functional polymers**

**Bridge between Academy and Industry**

**Surface science and catalyst characterization**

---

CAT

HOKKAIDO UNIVERSITY
1. Purpose of external evaluation

1. Periodical Evaluation

2. We will have the intermediate evaluation about Joint Usage /Research Program by MEXT (Government) in 2018.

3. We will submit the proposal to a new program called “International Joint Usage/Research Program” starting in October 2018.
2.1 Missions of ICAT

1. ICAT performs the fundamental researches to reveal the basic concepts about catalysis and to develop the new catalysts.

2. ICAT transfers these new concepts and catalysts to industry and society in order to realize the catalyst-induced innovation and to the sustainable society.

3. ICAT develops next generation researchers and leaders through the above activities.

4. Joint Usage / Research Center
2.3 The ICAT strategy

1. Three-departments system to promote the fundamental science and to put it into practical application.  ← diversity of the research

2. Accumulation and Application of the knowledge about catalysis and catalysts. ← Catalyst Informatics

3. Expansion of our Activities to Different Science Fields. ← diversity of the research

4. Inter-organizational Cooperation ← a member of IRCCS, collaborations with AIST, KEK, RIKEN, and NIMS

5. Establishment of Global Catalysis Network ← MOU between world-wide research centers and institutes.
2.4 Institute for Catalysis

Steering Committee

Diector

Faculty Meeting

Joint Research Evaluation Committee

Department of Fundamental Research

Department of Practical Applications

Target Research Department

Catalysis Collaboration Research Center (CCRC)

Technical Division

Research and Development Division

Unit for Exploitation of Intellectual Properties Relating to Photocatalysis

Unit for Industry-Government-Academia Collaborative Research on Catalysis

Unit of Fritz-Haber-Institute

Unit for Alliance Research with Polish Institutions

Unit on Integrated Research Consortium on Chemical Sciences

Consortium for Research on Electron Traps in Materials

Catalyst Surface
Catalysis Theory
Photocatalysis
Catalytic Transformation
Catalyst Material
Molecular Catalyst
Macromolecular Science
Target-Oriented Research Assembly  (Poster Presentation) 8

Central Research Section

Hasegawa Cluster

Extensive Research Section
Takakusagi Cluster
Zhou Cluster
Nakajima Cluster
Nakayama Cluster
Kowalska Cluster
Furukawa Cluster

Intra-Lab. Collaboration

Dynamic Collaboration

Innovation to New Catalysis

Conceptual Design

Leaders are associate professors

ICAT Fundamental Research Division

Domestic Institutes

Foreign Institutes

Researchers outside ICAT
2.6 Principle of human affairs.

(1) All professors are adopted through open recruitment.
(2) Internal promotion is forbidden.
(3) The division is closed after the Full professor retirement.

To keep the high rate of brain circulations

<table>
<thead>
<tr>
<th>Move-in Professors</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Total</th>
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<tr>
<td>Associate</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>6</td>
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<td>Assistant</td>
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<td>0</td>
<td>0</td>
<td>3</td>
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<tr>
<td>Move-out Professors</td>
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<td>1</td>
<td>0</td>
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<td>2</td>
<td>2</td>
<td>1</td>
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### 3. Activities

<table>
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<tr>
<th>Fiscal Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Average</th>
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<tr>
<td>Papers</td>
<td>81</td>
<td>103</td>
<td>90</td>
<td>89</td>
<td>89</td>
<td>90.4 (25.6)</td>
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<tr>
<td>(Number of international collaborations)</td>
<td>(26)</td>
<td>(28)</td>
<td>(22)</td>
<td>(22)</td>
<td>(30)</td>
<td></td>
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<tr>
<td>Top 10% papers</td>
<td>19</td>
<td>26</td>
<td>15</td>
<td>15</td>
<td>19</td>
<td>18.8</td>
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<tr>
<td>Top 1% papers</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Invited talks</td>
<td>67</td>
<td>84</td>
<td>85</td>
<td>88</td>
<td>94</td>
<td>82</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Award</th>
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<tbody>
<tr>
<td>2015</td>
<td>M. Osawa</td>
<td>ISE Fellow</td>
</tr>
<tr>
<td>2015</td>
<td>A. Fukuoka</td>
<td>Catalysis Society of Japan Award</td>
</tr>
<tr>
<td>2015</td>
<td>K. Asakura</td>
<td>Surface Science Society of Japan Award</td>
</tr>
<tr>
<td>2016</td>
<td>A. Fukuoka</td>
<td>Green Sustainable Award from MEXT</td>
</tr>
<tr>
<td>2016</td>
<td>K. Asakura</td>
<td>Catalysis Society of Japan Award</td>
</tr>
<tr>
<td>2017</td>
<td>H. Kobayashi</td>
<td>Chemical SJ, Young Chemist Award</td>
</tr>
<tr>
<td>2017</td>
<td>S. Furuwaka</td>
<td>Catalyst SJ, Young Scientist Award</td>
</tr>
<tr>
<td>2017</td>
<td>S. Furuwaka</td>
<td>JIMM, Young Scientist Award</td>
</tr>
</tbody>
</table>
We are working in collaboration with the prestigious research Institutes of Nagoya University, Kyoto University and Kyushu University.
3.3 ICAT International Symposium in Japan and Abroad

Novel Catalysis for Energy and Environmental Issues
Pre-symposium of 16th International Congress on Catalysis
2nd International Symposium of Institute for Catalysis
Sapporo, Hokkaido (June 30 - July 1, 2016)

Dear all participants,
On behalf of the Organizing Committee of pre-symposium of the 16th ICC-Pre in Sapporo,
we would like to extend our deepest appreciation for your participation in the symposium.
It is our great pleasure to provide this opportunity for all members belonging to international catalysis community.
We believe that you have a lot of fruitful discussion in oral and poster session.

Photos of this symposium have been uploaded. Please check here.

Thanking again all for the highly successful symposium.

Sincerely yours.

Pre-ICC2016

Catalysis Informatics

Korea-Japan Symposium on Catalysis
May 15-17, 2017
3.4 Joint Usage / Research Activity.

1. Proposal-based Joint Research under the open applications

2. APTCC(Advanced Practical Training Course for Catalysis)

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2012-2016 (ave)</th>
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<tr>
<td>Applications</td>
<td>43</td>
<td>35</td>
<td>30</td>
<td>22</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>Accepted</td>
<td>21</td>
<td>25</td>
<td>22</td>
<td>22</td>
<td>30</td>
<td>24</td>
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<tr>
<td>APTCC</td>
<td>11</td>
<td>11</td>
<td>18</td>
<td>19</td>
<td>12</td>
<td>14.2</td>
</tr>
<tr>
<td>PI</td>
<td>Collaborator in ICAT</td>
<td>Journal</td>
<td>Title</td>
<td>Awards or Recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>---------------------</td>
<td>---------</td>
<td>-------</td>
<td>----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. Y. Uemura</td>
<td>K. Asakura</td>
<td>Angewandte Chemi, 56, 1354 (2016)</td>
<td>Dynamics of Photoelectrons and Structural Changes of Tungsten Trioxide Observed by Femtosecond Transient XAFS</td>
<td>JSSR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. K. Tanino</td>
<td>A. Nakayama</td>
<td>Nature Commun. 6, 8731 (2015)</td>
<td>Total Synthesis of Palau’amine</td>
<td>Top 1% paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof. A. Onda</td>
<td>A. Fukuoka</td>
<td>J. Cat. 296, 34 (2012)</td>
<td>1-Butanol Synthesis from Ethanol over Strontium Phosphate Hydroxypatite Catalysts with Various Sr/P Ratios</td>
<td>Top 10% paper</td>
<td></td>
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</tr>
</tbody>
</table>
### 4.1 Education

Each professor has classes in each department.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal Researchers</td>
<td>38(12)</td>
<td>58(21)</td>
<td>42(23)</td>
<td>42(23)</td>
<td>17(8)</td>
<td>197(87)</td>
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<tr>
<td>Graduate Students</td>
<td>69(19)</td>
<td>68(24)</td>
<td>59(19)</td>
<td>57(19)</td>
<td>51(20)</td>
<td>304(101)</td>
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<tr>
<td>Undergraduate</td>
<td>8</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>45</td>
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<tr>
<td>Research Student</td>
<td>4(4)</td>
<td>1(1)</td>
<td>0(0)</td>
<td>2(2)</td>
<td>6(6)</td>
<td>13(13)</td>
</tr>
<tr>
<td>Oversea training</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>6</td>
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<tr>
<td>PhD</td>
<td>3(2)</td>
<td>4(3)</td>
<td>9(3)</td>
<td>7(2)</td>
<td>9(4)</td>
<td>32(14)</td>
</tr>
</tbody>
</table>

(From abroad)

5 professors belong to Graduate School of Chemical Science and Engineering. Each of 3 others belong to Graduate Schools of Life Science, Environmental Science and Engineering.
5 Logistics and administration

5.2 Budget

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Budget Through university</th>
<th>Budget Grant-in-aid for scientific research</th>
<th>Budget Research grant (Government)</th>
<th>Budget Research grant (Companies)</th>
<th>Budget Donation</th>
<th>Budget Others</th>
<th>Budget Indirect</th>
<th>Budget Sum</th>
</tr>
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<tbody>
<tr>
<td>2012</td>
<td></td>
<td></td>
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<td></td>
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<td>2013</td>
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<td>2014</td>
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<td>2015</td>
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<tr>
<td>2016</td>
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</tbody>
</table>

*Yen in 1000*
5.3 Technical Division

Glassblowing

Machine shop

Catalyst Instrument

NMR, XPS, TEM, SEM, BET

Ishikawa  Yamagishi  Hasegawa  Mukai  Shimoda  Kawamura
Director Junya Hasegawa

Mission

To promote catalyst science for sustainable society.

To construct International catalysis network.

To reinforce collaborations with the other institutes.

To accelerate practical applications.

To promote the database and catalysis informatics.
CCRC News #1
May 1, 2016

Catalysis Collaborative Research Center (CCRC)

September 2016 in the Netherlands.

CCRC News #2
August 26, 2016

CCRC News #11
October 9, 2017

Graduate School of Chemical Sciences and Engineering, Hokkaido University, provides a global educational program, "Advanced Graduate School of Chemistry and Materials Science (AGS)". In this program, highly motivated Ph.D. Students have an opportunity to stay and do collaboration work at prominent research institutes in overseas countries. Owing to the cooperation by Theory Department at Fritz-Haber-Institute (FHI), Roy Mizukami (DI) enjoyed a collaborative research work with Prof. Schaeffler (Director) and Dr. Levchenko (Group leader). The theory department at FHI is a worldwide prominent institute where advanced theory, catalysis concept, and computational techniques have been developed. Roy acquired precious experience by working together with the top scientists. We sincerely thank Theory department, FHI for the cooperation on collaborations, education, and warm hospitality.

(Jun-ya Hasegawa)

(From the left, Nakayama, Hasegawa, Asakura, Zilberberg, Zhangpeisov, Sando)

Since July, Prof. Zilberberg from Borsok Institute of Catalysis (BIC), Russia, is visiting ICAT. BIC is the world largest institute in the field of catalytic science. The scope of the BIC spans from basic development of catalysis to industrialization of promising catalysts. About 200 academic researchers and 1200 staffs are involved! Prof. Zilberberg is leading the quantum chemistry laboratory. On August 25, we organized BIC-ICAT Workshop. I wish that this event promotes to expand the collaborative network at institution level. From the BIC side, Prof. Zilberberg and Prof. Zhangpeisov (Tokohu Univ., a former member of BIC) gave talks on the electronic mechanism of catalytic reactions. From ICAT, Prof. Asakura (director) presented the excited-state dynamics of WO3 studied with the pump-probe XFEL measurement. Hasegawa showed transition state and reaction pathway of the intersystem crossing reactions.

(Jun-ya Hasegawa)
6.1.2 Research and Development Division

Prof. Mayumi Nishida

Industrialize the University’s Technology
Induce Problem-Solution Research

Cross Appointment Professor with AIST

Mission of the R&D Division

Reinforcing government-industry-academia collaboration

Academia  Research  Government  Business  Industry

HOKKAIDO UNIVERSITY
To promote international exchange, the ICAT has concluded agreements with its counterparts in many other countries.

1. School of Chemical Engineering, China University of Petroleum, China (December 7, 2001)
2. Department of Chemistry, East China Normal University, China (March 18, 2006)
3. Fritz Haber Institute of the Max Planck Society, Germany (December 2, 2005)
4. Center for Catalytic Science and Technology, Delaware University, USA (July 9, 2007)
5. State Key Laboratory of Physical Chemistry of Solid Surfaces, Xiamen University, China (October 9, 2007)
6. State Key Laboratory of Catalysis, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China (October 10, 2007)
7. Institute for Physical Research and Technology, Iowa State University, USA (March 10, 2006)
8. Cardiff Catalysts Institute, Cardiff University, UK (January 26, 2010)
9. Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland (March 15, 2010)
10. Institute of Chemical and Environmental Engineering, West Pomeranian University of Technology, Szczecin, Poland (March 17, 2010)
11. Gdansk University of Technology, Poland (March 18, 2010)
12. Unité de Catalyse et de Chimie du Solide Université Lille 1 et Ecole Centrale de Lille, France (January 17, 2011)
13. College of Science, Purdue University, USA (April 26, 2014)
14. Department of Chemical Engineering, University of South Carolina, USA (March 24, 2016)
15. Faculty of Chemistry, Jagiellonian University, Poland (May 11, 2016)
16. Boreskov Institute of Catalysis, Russia (October 11, 2016)
17. SUNCAT Center for Interface Science and Catalysis, USA (November 2, 2016)
18. Department of Chemistry, Renmin University of China, China (November 18, 2016)
6.1.4 Invited Guest Professors

Stay with us for more than 1 month.
To carry out collaboration researches and education.

2017 Prof. Janczarek Marcin  
   Prof. Jochen Lauterbach  
   Prof. A. Bedilo

2016 Prof. P.R. Sarode (from Goa University)  
   Prof. I. Zilberberg (from Boreskov Institute of Catalysis)  
   Prof. Zhiping Li (Renmin University of China)  
   Prof. E. J.M. Hensen (TU Eindhoven)

2015 Prof. H.J. Freund (FHI, Germany)  
   Prof. Chang Wei (China, University Soochow)

2014 Prof. W. Macyk; M. Kotora; T. Cuenca

2013 Prof. B.C. Gates; Mauriello Francesco; Chen Zhan; Sanchez Cortes Santiago; Adriana Pietropaolo
6.2 Catalyst Informatics

Collect all data and extract new catalysts or new concept by machine learning.

Database

All data in the one

Joint Symposium on Catalyst Informatics (2015～) with AIST, RIKEN, and NIMS。

Machine learning helps researchers tackle challenging tasks, such as designing pollution filter catalysts at industrial scale.

Chemistry World
http://www.rsc.org/chemistryworld/2016/06/machine-learning-catalyst-metal-trends
Takigawa, I., Shimizu, K.-i., Tsuda, K. & Takakusagi, S.
### 6.2 Database

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<th>Registered No</th>
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<td>XAFS (En)</td>
<td>XAFS Spectra database</td>
<td>218</td>
</tr>
<tr>
<td>Photo Catalysis (J)</td>
<td>Full page database for Photocatalyst newsletter (J)</td>
<td>413 +1528</td>
</tr>
</tbody>
</table>

Database: http://www.cat.hokudai.ac.jp/catdb/
6.3 Future vision of ICAT

Catalyst driven Innovations
Catalysts for Sustainable Society

- Exhausted plastic and wood, CO$_2$
- FEEDSTOCK
- New Energy
- New Material
- Database
- Catalyst Informatics
- Technological application division
- Air
- Sunlight
- Biomass
- Methane hydrate, Shale gas
- Solid catalyst, molecular catalyst
- New catalyst materials
- Functional Molecule
- Energy conversion
- Purification
- Spectroscopy and theory
- Hub of International Network
- Collaboration with Universities and Research Institutes
- Collaboration with National Research and Development Agencies.