

赤い枠をクリックすると見本のページにジャンプします

触媒技術の動向と展望 創刊 20 周年記念企画別冊英語版  
「Special Edition for the 20<sup>th</sup> Anniversary of Publication of “Annual Survey of Catalytic Science and Technologies” by the Catalysis Society of Japan」のご案内

触媒学会では 1993 年度から事業の一環として、「触媒技術の動向と展望」と題した年鑑の出版を行っております。

創刊 20 周年記念号の 2012 年度版では、金属触媒、酸化物触媒、生体・錯体触媒、重合触媒、キャラクターゼーション、光触媒、石油化学、高分子合成、バイオベース化学の九つの触媒分野における研究開発の歴史と将来展望をまとめた特集を掲載しております。

この特集の英語版ならびに大学・高専・国公立研究機関における研究活動(研究者総覧)の英語版を別冊として製本し、販売いたします。

この別冊は海外の触媒研究者に日本における触媒の研究動向、研究者を紹介する際にもお役立ていただける内容となっています。また、大学院にて触媒研究を行っている院生等にとりましても必読の書となっています。

つきましては本別冊の有用性をご賢察の上、ぜひご購入いただきますようにご案内申し上げます。なお、5 冊以上まとめてご購入いただけます場合は割引価格を準備いたしておりますので事務局までお問い合わせください。

「創刊 20 周年記念企画別冊英語版」 (379 頁) 価格 6,000 円 (消費税込)

ご購入は、「住所、会社名及び部署名、お名前、電話番号、FAX 番号、E-mail アドレス」を明記のうえ、触媒学会事務局まで E-Mail ([catsj@pb3.so-net.ne.jp](mailto:catsj@pb3.so-net.ne.jp)) または FAX (03-3291-8225) にて お申し込みください。

Special Edition for the 20<sup>th</sup> Anniversary of Publication of  
“Annual Survey of Catalytic Science and Technologies”  
by the Catalysis Society of Japan

1. Contributions to the Special Edition

- 1.1 Prosperous future of catalysis: Greetings from the President  
Tokyo Metropolitan University Masatake Haruta 3
- 1.2 A submission to the 20<sup>th</sup> anniversary commemorative edition  
The Catalyst Manufacturers Association, Japan Yujiro Saito 5
- 1.3 The history and development of metallic catalysts  
Industrial Catalyst Laboratory Takashiro Muroi 8
- 1.4 Complication towards evolution in the history of oxide catalysts for selective oxidation  
Catalyst Research Center, Hokkaido University Wataru Ueda 18
- 1.5 Development of homogeneous catalysis and biocatalysis over past two decades  
Chemical Resources Laboratory, Tokyo Institute of Technology Munetaka Akita 26
- 1.6 Recent trends in olefin polymerization catalyst development  
Mitsui Chemicals Singapore R&D Center Pte.Ltd. Haruyuki Makio, Terunori Fujita 38

1.7 Past, present and future of catalyst characterization	
	Catalyst Research Center, Hokkaido University Kiyotaka Asakura 51
1.8 History and outlook of photocatalyst research	
	The University of Tokyo Kazuhiko Maeda, Kazunari Domen 60
1.9 Development of the Japanese chemical industry over past decades and prospects for research in the 21 <sup>st</sup> century	
	Mitsubishi Chemical Group Science and Technology Research Center Corp. Tohru Setoyama 72
1.10 Historical Stream, Trends and Outlook for Polymerization Catalysts	
	Tokyo Metropolitan University Kotohiro Nomura 80
1.11 Bio-based chemicals towards green innovation	
	Kyoto Gakuen University Sakayu Shimizu 92

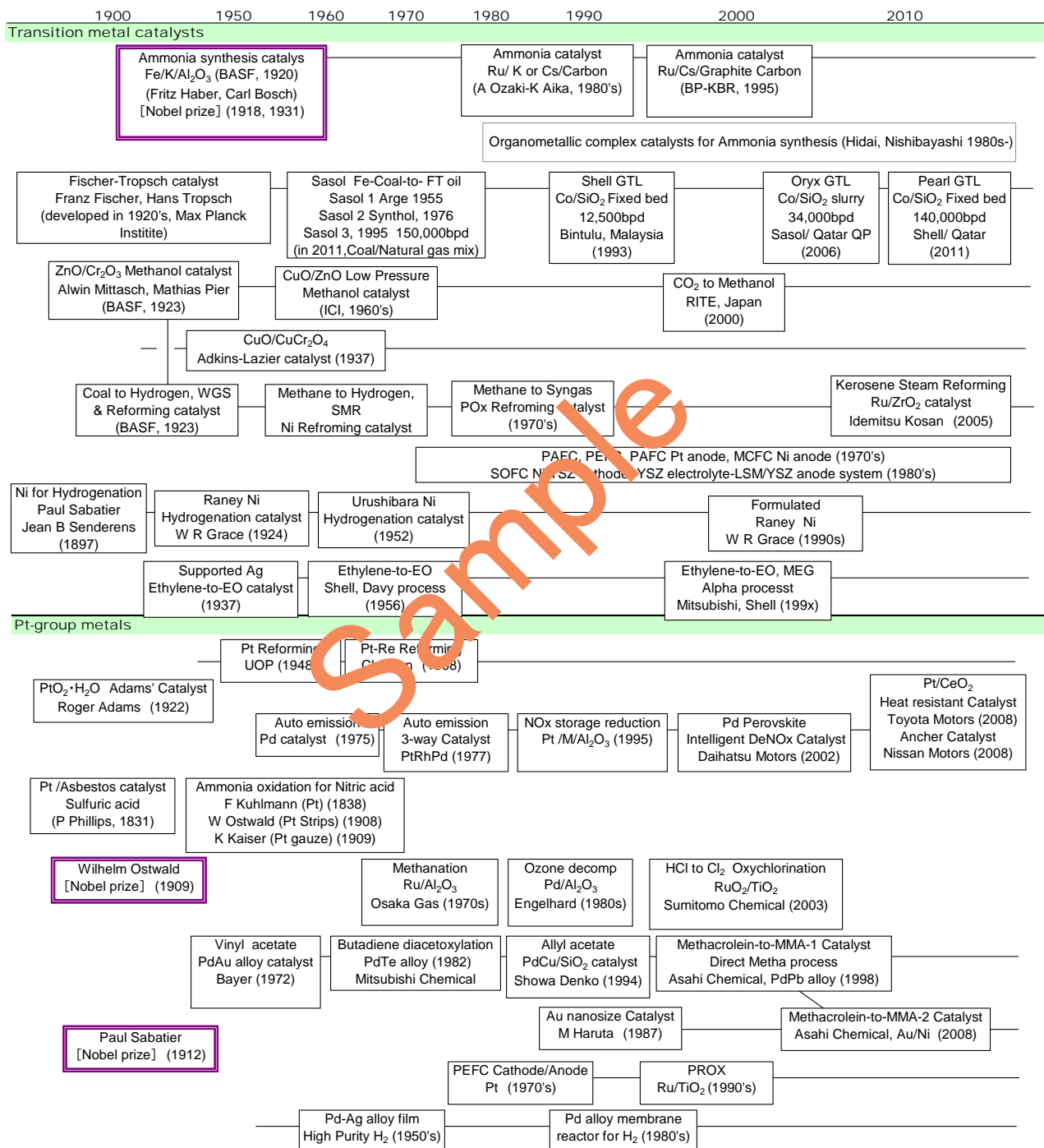
## 2. Recent activities of Japanese academic organizations

Aichi University of Technology	107	Kobe University	166
Akita University	107	Kochi National College of Technology	169
Asahikawa National College of Technology	109	Kochi University	169
Central Research Institute of Electric Power Industry	110	Kogakuin University	170
Chiba Institute of Technology	111	Kyoto Institute of Technology	171
Chiba University	112	Kyoto University	172
Chuo University	115	Kyushu Institute of Technology	184
Doshisha University	117	Kyushu University	186
Ehime University	119	Kumamoto University	198
The University of Electro-Communications	121	Meiji University	199
Gifu University	122	Meisei University	200
Gunma University	125	Mie University	200
Hakodate National College of Technology	126	University of Miyazaki	201
Hirosaki University	126	Muroran Institute of Technology	203
Hiroshima University	127	Nagaoka University of Technology	204
Hokkaido University	130	Nagasaki University	205
Hokkaido University of Education	144	Nagoya Industrial Science Research Institute	208
University of Hyogo	146	Nagoya Institute of Technology	208
Ibaraki National College of Technology	147	Nagoya Municipal Industrial Research Institute	209
Ichinoseki National College of Technology	147	Nagoya University	210
International Christian University	148	Nara Institute of Science and Technology	219
Ishinomaki Senshu University	149	Nara Women's University	220
Japan Advanced Institute of Science and Technology	150	National Defense Academy	221
Kagoshima University	152	National Institute of Advanced Industrial Science and Technology	222
Kanagawa University	153	National Institutes of Natural Sciences	237
Kansai University	156	Nihon University	239
Keio University	159	Numazu National College of Technology	241
Kinki University	160	Okayama Ceramics Research Foundation	242
The University of Kitakyushu	161		
Kitami Institute of Technology	162		

Okayama University.....	243	The University of Tokushima .....	299
Oita University .....	247	The University of Tokyo.....	301
Osaka University .....	249	Tokyo Institute of Technology .....	309
Osaka Prefecture University.....	267	Tokyo Metropolitan University .....	323
Research Institute of Innovative Technology for the Earth.....	272	Tokyo University of Agriculture and Technology .....	325
RIKEN.....	273	Tokyo University of Science.....	327
Ritsumeikan University.....	274	Tokyo University of Science Yamaguchi .....	329
Ryukoku University .....	275	Tottori University.....	330
Sagami Chemical Research Institute.....	276	University of Toyama .....	332
Saitama University .....	278	Toyama Industrial Technology Center..	336
Seikei University.....	279	Toyohashi University of Technology....	336
Industrial Research Center of Shiga Prefecture .....	280	Toyota Technological Institute.....	339
Shimane Institute for Industrial Technology .....	281	University of Tsukuba.....	339
Shimane University .....	282	Ube National Collage of Technology ...	341
Shinshu University .....	283	Utsunomiya University .....	341
Shizuoka University .....	285	Waseda University .....	344
Sophia University .....	288	Yamaguchi University .....	350
Tohoku University.....	290	University of Yamanashi.....	351
Tokai University.....	297	Yokohama National University.....	353
INDEX			356

# The history and development of metallic catalysts

Takashiro Muroi<sup>※</sup>



121212

※ Industrial Catalysts Laboratory, 5-8-5 Kariya, Ushiku, 300-1235 Ibaraki, Japan

## ***1. Introduction***

The fundamentals of industrial catalysts used in modern chemical and environmental processes were discovered by the middle of the 20th century. In these first-generation processes, severe reaction conditions were applied, resulting in high construction and utility costs and performance that was inferior to that found in modern chemical plants. The second generation catalysts developed in the latter half of the 20th century were more sophisticated. They not only extended the variety of usable feedstocks and products manufactured, but also reduced the consumption of material and energy inputs, thus achieving higher profitability and lower environmental emissions. These catalysts were developed primarily for continuous and commercial-scale processes, and contributed to the establishment of a modern and prosperous chemical industry. Even in ammonia synthesis, the highest pressure and high temperature process in the chemical industry, Japanese chemists discovered a Ru/Cs-based high-performance catalyst in the 1980s that can function at much lower pressure and temperature. The first commercial use of this Ru/Cs-based catalyst was by BP-KBR in 1996. Further progress and enhanced contributions from catalysts is expected moving forward in order to combat global warming and an anticipated shortage of fossil fuel resources in the near future.<sup>1)</sup>

## ***2. The history of metallic catalysts***

### ***2.1 1831-1900 (In the beginning)***

Metallic catalysts were already utilized in the nascent stages of the chemical industrial revolution in the 19th century in Europe. An asbestos-supported Pt (P. Phillips, 1831) was the first catalyst that appeared in industry for the commercial production of sulfuric acid, an important material for producing sodium carbonate by the Leblanc process (N. Leblanc, 1791). The chamber process (introduced in 1746), or NO<sub>2</sub>-catalysed SO<sub>2</sub> oxidation process, was gradually switched to the new catalytic process. In 1913, F. Slama and H. Wolf patented, a catalyst made of a salt of vanadic acid with alkali promoters on a porous support for this process. The V<sub>2</sub>O<sub>5</sub>-alkali catalyst became popular soon after this finding, replacing all the Pt-catalysed processes. Nitric acid, another basic material in the chemical industry, was produced by acidolysis of KNO<sub>3</sub> with sulfuric acid when Alfred Nobel developed dynamite in 1866. The concept of vapor phase oxidation of ammonia to nitric acid was proposed by F. Kuhlmann in 1838, but the first industrial process was only developed in the 1920s, when an ample supply of gunpowder was required and the Pt gauze (multiple layers of a fine wire mesh) catalyst was invented. The activity of various finely-dispersed metallic hydrogenation catalysts was studied by Paul Sabatier, who together with Jean B. Senderens in France discovered the Ni catalyst for hydrogenation of unsaturated compounds in 1897. In the same year Joseph Crosfield & Sons succeeded in producing hardened (or hydrogenated) oil via Ni catalyzed hydrogenation of fish and vegetable oils in the UK.

### ***2.2 1900-1960 (Rise of metallic catalysts and coal era)***

Many new catalytic processes were developed during the golden era of 1900 to the 1920s. Production of nitric acid was started via catalytic oxidation of ammonia with a coil of Pt strips by Wilhelm Ostwald in 1906, and soon after with a Pt gauze catalyst developed by K Kaiser in 1909. Further, ammonia was produced via the calcium cyanamide process from calcium carbide.