Ryoji Noyori

Date of Birth 3 September 1938

Place Hyogo (Japan)

Nomination 1 October 2002

Field Chemistry

Title Professor, Nobel laureate in Chemistry, 2001

Professional address

Nagoya University, Department of Chemistry
Graduate School of Science
Chikusa, Nagoya 464-8602 (Japan)

Most important awards, prizes and academies

Awards: Japan Academy Prize (1995); Arthur C. Cope Award, American Chemical Society (1997); King Faisal International Prize for Science, Saudi Arabia (1999); Order of Culture, Japanese Emperor/Government (2000); Wolf Prize in Chemistry, Israel (2001); Roger Adams Award in Organic Chemistry, American Chemical Society (2001); Nobel Prize in Chemistry (2001). *Academies*: Foreign Honorary Member of the American Academy of Arts and Sciences (2001); Honorary Member of the European Academy of Sciences and Arts (2001); Pontifical Academy of Sciences (2002); Foreign Associate of the National Academy of Sciences, USA (2003); Foreign Member of the Russian Academy of Sciences. *Honorary Professorships*: Shanghai Institute of Organic Chemistry; Hong Kong Polytechnic University; South China University of Technology. *Honorary Degrees*: Technische Universität Munchen; University of Rennes; University of Bologna; University of Alicante; Uppsala University; University of Ottawa; University of Chicago; RWTH Aachen University.

Summary of scientific research

Ryoji Noyori is well known for his initiation (1966) and development of asymmetric catalysis using chiral organometallic compounds. The efficiency of the asymmetric catalysts discovered by Noyori equals or, in certain cases, even exceeds that of enzymes. Applications of his original and versatile chemistry have allowed him and other scientists to achieve truly efficient syntheses of organic molecules of theoretical and practical importance. In particular, chemistry based on the BINAP ligand invented by Noyori in 1980 has been practiced in research laboratories worldwide as well as on an industrial scale. Noyori's major accomplishments include the development of practical asymmetric hydrogenation of functionalized olefins and ketones using chiral Ru-BINAP complexes; Rh catalyzed asymmetric isomerization of geranylamine to citronellal enamine; the demonstration of the general utility of dynamic kinetic resolution in asymmetric catalysis; the invention of chiral Ru catalysts effecting highly selective asymmetric transfer hydrogenation of ketones and imines; the discovery of highly enantioselective addition of dialkylzincs to aldehydes catalyzed by chiral amino alcohols and the elucidation of the molecular mechanism of the chirality amplification phenomenon. These methods have found application in syntheses of numerous important products including menthol, carbapenem antibiotics, anti-bacterial agents and prostaglandins.

Main publications

Miyashita, A., Yasuda, A., Takaya, H., Toriumi, K., Ito, T., Souchi, T. and Noyori, R., Synthesis of 2,2'-Bis(diphenylphosphino)-1,1'-binaphthyl (BINAP), an Atropisomeric Chiral Bis(triaryl)phosphine, and Its Use in the Rhodium(I)-Catalyzed Asymmetric Hydrogenation of α–(Acylamino)acrylic Acids, *J. Am. Chem. Soc.*, 102, p. 7932 (1980); Noyori, R. and Hayakawa, Y., Reductive Dehalogenation Polyhalo Ketones with Low-Valent Metals and Related Reducing Agents, *Org. React.*, 29, p. 163 (1983); Noyori, R. and Suzuki, M., Prostaglandin Syntheses by Three-Component Coupling, *Angew. Chem. Int. Ed. Engl.*, 23, p. 847 (1984); Hayakawa, Y., Wakabayashi, S., Kato, H. and Noyori, R., The Allylic Protection Method in Solid-Phase Oligonucleotide Synthesis. An Efficient Preparation of Solid-Anchored DNA Oligomers, *J. Am. Chem. Soc.*, 112, p. 1691 (1990); Noyori, R. and Suzuki, M., An Organometallic Way to Prostaglandins: The Three-Component Coupling Synthesis, *Chemtracts-Org. Chem.*, 3, p. 173 (1990); Noyori, R., Chiral Metal Complexes

as Discriminating Molecular Catalysts, *Science*, 248, p. 1194 (1990); Noyori, R. and Takaya, H., BINAP: An Efficient Chiral Element for Asymmetric Catalysis, *Acc. Chem. Res.*, 23, p. 345 (1990); Noyori, R. and Kitamura, M., Enantioselective Addition of Organometallic Reagents to Carbonyl Compounds: Chirality Transfer, Multiplication, and Amplification, *Angew. Chem. Int. Ed. Engl.*, 30, p. 49 (1991); Noyori, R., *Asymmetric Catalysis in Organic Synthesis*, John Wiley & Sons, New York (1994); Noyori, R., Tokunaga, M. and Kitamura, M., Stereoselective Organic Synthesis via Dynamic Kinetic Resolution, *Bull. Chem. Soc. Jpn*., 68, p. 36 (1995); Jessop, P.G., Ikariya, T. and Noyori, R., Homogeneous Catalysis in Supercritical Fluids, *Science*, 269, p. 1065 (1995); Noyori, R. and Hashiguchi, S., Asymmetric Transfer Hydrogenation Catalyzed by Chiral Ruthenium Complexes, *Acc. Chem. Res*., 30, p. 97 (1997); Sato, K., Aoki, M. and Noyori, R., A "Green" Route to Adipic Acid: Direct Oxidation of Cyclohexenes with 30% Hydrogen Peroxide, *Science*, 281, p. 1646 (1998); Noyori, R. and Ohkuma, T., Asymmetric Catalysis by Architectural and Functional Molecular Engineering: Practical Chemo- and Stereoselective Hydrogenation of Ketones, *Angew. Chem. Int. Ed.*, 40, p. 40 (2001); Noyori, R., Suga, S., Oka, H. and Kitamura, M., Self and Nonself Recognition of Chiral Catalysts: The Origin of Nonlinear Effects in the Amino-Alcohol Catalyzed Asymmetric Addition of Diorganozincs to Aldehydes, *Chem. Rec.*, 1, p. 85 (2001); Noyori, R., Yamakawa, M. and Hashiguchi, S., Metal-Ligand Bifunctional Catalysis: A Nonclassical Mechanism for Asymmetric Hydrogen Transfer between Alcohols and Carbonyl Compounds, *J. Org. Chem.*, 66, p. 7931 (2001); Noyori, R., Asymmetric Catalysis: Science and Opportunities (Nobel Lecture), *Angew. Chem. Int. Ed*., 41, p. 2008 (2002).