Henri Moissan
Nobel laureate in Chemistry1906

At its meeting on November 12 1906 the Royal Swedish Academy of Sciences decided to give The Nobel prize in Chemistry to the French chemist Henri Moissan "in recognition of the great services rendered by him in his investigation and isolation of the element fluorine, and for the adoption in the service of science of the electric furnace called after him".

This report is a brief surnmary of the deliberations that preceeded the decision of the Academy, of the research of Moissan and its importance for later technical innovations.

The early Nobel prizes in Chemistry

A difficulty for the committees appointed for evaluating the nominations was the stipulation in the will of Alfred Nobel that the prizes should be given for achievements during the preceeding year. The interpretation of this part of the will, as formulated in 2§ of the statutes established by the Swedish government on June 29 1900, was that the most recent results in the field should be considered, while earlier results would only be rewarded if their importance had not been realised until recently. This paragraph had pIayed an important role for the choice of the relatively young prize winners in chemistry 1901-1904: van't Hoff (49) Fischer (50), Arrhenius (44) and Ramsay (52), when the contributions by eminent scientists like Berthelot, Ostwald, von Baeyer and Mendeleïev had been regarded as too old to be in line with the will. This view was challenged by Widman in the discussions of the 1905 prize when he succeeded in convincing his fellow members of the Nobel committee to suggest unaminously von Baeyer although the most important results of this eminent German organic chemist (who would celebrate his 70th birthday in 1905) were made 30-40 earlier, thus eliminating Moissan although the latter had received many more nominations.

The prize in chemistry 1906

The decision to award the price to von Baeyer in 1905 may have stimulated those who had previously nominated Mendelejeff, to renew their efforts, and the inventor of the periodic table become the choice of the majority of Nobel committee at its meeting on 21 September 1906. Before this meeting Otto Pettersson and Peter Klason had presented their controversial views on the two major candidates in elaborate PM:s (App.to the minutes), the former in support of Mendelejeff and the latter in support of Moissan. Peter Klason further developed his arguments, in a document dated September 18, why he did not agree with the majority. He could base his case on the numerous nominations of Moissan, e.g. the recommendation in a long letter from February 16 1906 by Becquerel and 14 other distinguished French scientists (among others P. Curie) and the letter, dated October 20 1904 (for the 1905 prize), from Emil Fischer, who described the work of Moissan as "Experimental-Arbeiten ersten Ranges". ln particular, Klason referred to the opinion expressed by William Ramsay, who had nominated Moissan both in 1904 and 1905 and who, in a letter from December 20 1904 said "it appears to me that Prof. Moissan comes more under the terms of the will". After having discussed Mendeleïev and Cannizzaro (and in passing three other names) the letter ended as follows: "I think I will ask you to let me recommend Prof. Moissan".

As a result of Peter Klason's action the chemical section of the Academy voted (with a small majority, 5 against 4) for proposing Moissan at its meeing on October 27 1906 thus going against the recommendation of its Nobel committee. On November 12 the Academy decided to award the 1906 Nobel prize in Chemistry to Henri Moissan. The new laureate was informed while he was in Alger and

sent his thanks by telegram on November 15 (p. 405 in the appendixes to the minutes from of the 1906 meetings) and in a later letter (p. 431-434) he repeated his thanks and suggested as title of his Nobel lecture: "La chimie des hautes températures". There is also in the Nobel archives a letter to Arrhenius, dated November 30, in which Moissan thanked for Arrhenius' offer to meet him and his wife at the central station and adding "*vous serez ainsi notre premier pilote dans votre beau pays"*. (It is reasonable to guess that Arrhenius spoke in favour of Moissan at the Academy meeting on November 12).

Moissan's *research*

Among the many papers on the achievements of Moissan that of Peter Klason from the 1905 discussions (App. E to the minutes from the meeting of the Nobel committee on September 9 1905) deserves to be particularly mentioned. He divided his report in two parts: first, the isolation and characterisation of fluorine and second, the research on carbon and the syntheses of carbides in the electical (arc) furnace. Like many later authors he could base his report on two books by Moissan: "Le fluor et ses composés" (1900), and "Le four électrique" (1897). Moissan later also published "Traité de la chimie minérale" (1905/06).

All through the 19th century many indications of the existence of fluorine had been reported, but it was not until Moissan made his experiment on electrolysing anhydrous HF at -25 C that it could be isolated. By an ingenious choice of materials he designed an apparatus in which up to 2 liter of fluorine gas per hour could be produced and he determined its chemical and physical properties, thus solving a problem that had occupied many distinguished chemists for decades. It is difficult to find a better example of "Experimental-Arbeiten ersten Ranges" to quote Fischer.

By the design of his electrical (arc) furnace Moissan could achieve temperatures above 3000 degrees and hence open a whole new field of high temperature chemistry. He studied carbon and its modifications, but of greater importance for subsequent technical applications were the syntheses of the carbides and related substances. He divided the carbides into two groups, those which react with water to produce hydrocarbons (e.g. calcium carbide) and the much less reactive hard refractory carbides of silicon, boron and the transition metals of the IVth to VIth groups, which due to their extreme hardness had found many applications. Of special interest are the tungsten carbides, W2C prepared by Moissan in his electrical fumace in 1896 and WC prepared in 1898 by a collaborator in his Paris laboratory, P. Williams (from a mixture containing iron, which was subsequently eliminated by a chemical treatment). ln view of the great technological impact of tungsten carbide on cutting and drilling technology, the pioneering research of Moissan on carbides can be regarded as of equal importance as his isolation of fluorine and may deserve a few comments.

Tungsten carbide

Tungsten carbide is as main component in cemented carbide, a new synthetic hard material invented by a research group at the Osram Studiengesellschaft in Berlin and presented in a patent, filed in 1923. The commercial introduction of this hard material, which was called "Hartmetall" by the inventors, was the starting point of the revolutionary development of cutting and rock drilling tools and the concomitant enormous increase in productivity in the manufacturing and mining industries during the latest 75 years. Not only have cemented carbide tools made a substantial contribution to the increase in our material living standard, they have also very much improved working condition, as for instance demonstrated by a comparison between the environment of a worker at the LKAB mines in Kiruna today and 70 years ago.

At the present time - 100 years after Moissan received the Nobel prize in Chemistry - we should not

forget that it all started with the synthesis of tungsten carbide in his electrical furnace.

The life of Henri Moissan

Ferdinand Frédéric Henri Moissan was born in Paris in 1852. After brilliant school studies at the college in Meaux, where the family lived 1864-1870, he studied at "Pharmacie Baudry" and "Ecole de Chimie expérimentale" in Paris and obtained his "Baccalauréat-ès-Science" in 1874. ln 1877 he started his career in inorganic chemistry and submitted his doctoral thesis on "the metallic oxides of the iron family" in 1880. He was appointed associate professor at "Ecole supérieure de Pharmacie" in 1880 and became full professor there in 1887. He was elected member of Académie des Sciences in 1891 and was appointed professor at Sorbonne in 1900. He designed his ingenious electical arc furnace in 1892 and in a series of experiments he extended the field of high temperature chemistry from 1600 C to 3000 C. He presented a series of paper on carbon in 1893 and subsequently began his studies of carbides. At the prize ceremony on December 10 1906 Peter Klason summarised Moissan' s contributions as follows:

"Monsieur le professeur MOISSAN,
Le monde entier a admiré la grande adresse expérimentale avec laquelle vous avez isolé et examiné le fluor, cette bête sauvage d'entre les éléments. Par vos travaux à l'aide de votre four électrique vous avez deviné l'énigme de la formation des diamants dans la nature. Vous avez soulevé une vague puissante dans tout le monde technique, vague qui n'a pas encore atteint toute sa hauteur. C'est en reconnaissance de ces mérites que notre Académie des Sciences vous a attribué le prix Nobel, et au nom de l'Académie je vous fais mes compliments pour vos travaux d'une si grande valeur, d'une valeur qui durera toujours".

Henri Moissan died from an appendicitis attack in February 1907, only two months after having received the Nobel prize in chemistry in Stockholm.

Stockholm, May 2006
Bertil Aronsson

This report is mainly based on documents at the Nobel archive of the Royal Swedish Academy of Sciences and the author wishes to thank its personnel for excellent assistance.