The Invention of Carborundum, the Synthetic Silicon Carbide

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# The Invention of Carborundum, the Synthetic Silicon Carbide

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## Abstract

In origin, the semiconductor Silicon Carbide was known as the Carborundum. Here a short history of its invention from the pen of its inventor Edward Goodrich Acheson.

## Article body

In origin, the semiconductor Silicon Carbide was known as the Carborundum. Extremely rare in the form of the natural moissanite, mineral discovered by Henri Moissan in 1893, the silicon carbide was invented and synthetically produced by Edward Goodrich Acheson in 1891 for its use as an abrasive. In 1893, Acheson received a patent on this highly effective abrasive. For what concerns electronic applications, it was known from the beginning of the twentieth century that carborundum could have been used for light-emitting diodes (LEDs) and detectors in wireless devices. LEDs are based on the phenomenon of electroluminescence, which is the production of light by the flow of electrons. This phenomenon was discovered in 1907 by Henry Joseph Round of Marconi Laboratories, when he used a crystal of carborundum in a cat's-whisker detector [1-3]. In [3], Round wrote that "during an investigation of the unsymmetrical passage of current through a contact of carborundum and other substances a curious phenomenon was noted. On applying a potential of 10 volts between two points on a crystal of carborundum, the crystal gave out a yellowish light. Only one or two specimens could be found which gave a bright glow on such a low voltage, but with 110 volts a large number could be found to glow". We find the LEDs based on SiC studied also by Oleg Losev, a Russian scientist [4]. In 1929, in introducing a patent, Losev wrote that LEDs could be used as detectors in optical relays for fast telegraphic and telephone communications, transmission of images and other applications. Actually, he had understood the potential of LEDs for telecommunications [4]. Today, silicon carbide is used in semiconductor electronics devices that operate at high temperatures or high voltages. Besides its electronic properties, SiC is characterized by a high thermal conductivity [5].
As we have seen, at the beginning of its history, SiC was known with its trade name carborundum. In [6], we considered the two terms 'carborundum' and 'silicon carbide' for a search by means of Ngram Viewer, a tool provided by Google to be used on Google books. The result of this search is given in the Figure 7 of [6], here reproduced in the Figure 1.

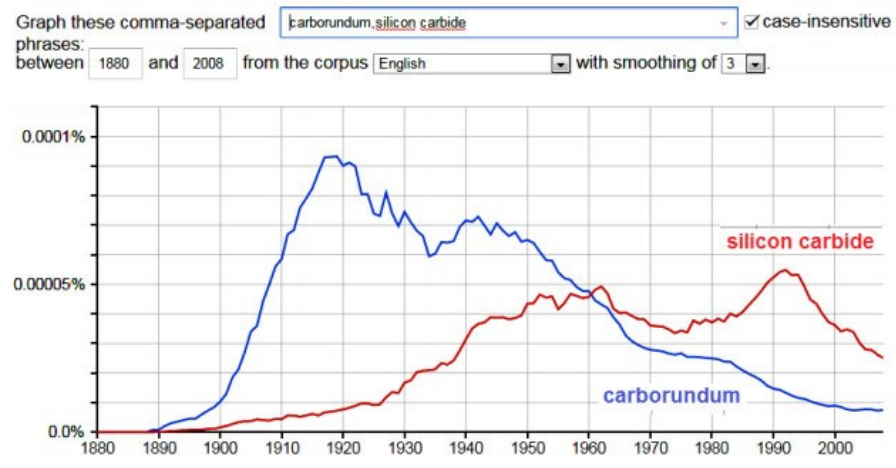


Figure 1: Carborundum and Silicon Carbide in Google Ngram Viewer [6].

Using the form of the Ngram Viewer, among the first publications on carborundum we find the book entitled "Carborundum: Its History, Manufacture and Uses", written by Acheson and published in 1893.

As previously told, Edward Goodrich Acheson (1856-1931) was the American chemist who invented the synthetic silicon carbide. He was the inventor of the Acheson process, still used to produce carborundum [7] (let us note that when he invented the synthetic SiC he also invented the synthetic graphite). In [8], it is shortly described the process for obtaining the carborundum from a mixture of silica and carbon. At relatively low temperatures the silica-carbon mixture yields a greenish-colored amorphous substance, but as the temperature is increased this is converted into crystalline silicon carbide. "If the temperature is increased considerably beyond that of its formation, carborundum is decomposed, the silicon being expelled as vapor and the carbon left behind in the form of graphite" [8]. And therefore, in 1896, Acheson was granted a patent for the graphite manufacture too. Commercial production started in 1897. As told by Wilder D. Bancroft, President of the American Chemical Society, in the course of an entertaining address: "To make carborundum he needed electrodes, so he invented graphite. A suitable refractory was needed to keep the heat in the furnace, and Mr. Acheson thereupon prepared siloxicon", a refractory material [9]. "You may consider Mr. Acheson's discoveries as scientific inventions or as dividend payers. It makes no difference. They stand all tests, and they mark him as one of the great inventors of the world."

In the Internet Archive, the non-profit digital library which is providing free public access to collections of digitized materials, we can find what Acheson wrote about the discovery of carborundum [9,10]. In [9], we have a detailed report of the discovery. Acheson "did quite a great deal of experimenting during the Winter on various lines. I think it was in February, 1891, I was working on the making of rubber synthetically. I succeeded in producing a small piece, when at this critical moment Mr. John S. Huyler came from New York to see our plant. He was not pleased with the prospects. … With this, he left me to my own resources. His remarks discouraged me regarding rubber; I dropped the subject and resolved to endeavor to produce an artificial abrasive. … The value of a good abrasive was brought to my attention by a remark incidentally made in 1880 by Dr. George F. Kunz of Tiffany & Company, New York. I also remembered the observation of clay impregnated with carbon I made at Gosford, and I decided to make experiments on impregnating clay with carbon under the influence of electric heat. An iron bowl, such as plumbers use for holding their melted solder, was attached to one lead from a dynamo and filled with a mixture of clay and powdered coke, the end of an arc light carbon attached to the other lead was inserted into the mixture. The percentage of coke was high enough to carry a current, and a good strong one was passed through the mixture between the lamp carbon and bowl until the clay in the center was melted and heated to a very high temperature" (for carbon-arc lamps see [11]). "When cold, the mass was examined. It did not fill my expectations, but I, by sheer chance, happened to notice a few bright specks on the end of the arc carbon that had been in the mixture. I placed one on the end of a lead pencil and drew it across a pane of glass. It cut the glass like a diamond. I repeated the experiment, and collected enough of the material to test its abrasive qualities". Then, a "friend by the name of W. C. McCallister, a druggist of Monongahela, and I started for New York. On the way we coined a name for my new and, as yet, unnamed material. Under the impression, without any chemical analysis, that it was composed of carbon and corundum, I called it Carborundum" (the corundum is a crystalline form of alumina, the aluminium oxide). Then, Acheson "organized The Carborundum Company, and incorporated it for one hundred and fifty thousand dollars on the 21st day of September, 1891". In [8] it is also told that "some months after the discovery of Carborundum", he learned from analyses that it was a compound of carbon and silicon, "and not alumina, the formula being SiC". This was the invention of carborundum as described by its inventor.

Some Acheson's publications and patents are given in [12-23].

In the Internet Archive, we can find other publications interesting for our short history on carborundum. In [24], we can see the manufacture of Carborundum at Niagara Falls, with several illustrations, and in [25] a treatise on abrasives. In [26], we find the material described for a radio detector. "The usual crystal detector uses a crystal of galena, which, while it is the most sensitive crystal that we can find, has one disadvantage, in that it is easily jarred out of adjustment". In [26], it is therefore suggested and discussed the carborundum as crystal detector.

Let us conclude by mentioning document [27], from the Internet Archive too. The title of the document illustrates the use of the word carborundum in a pseudo-Latin aphorism "Illegitimi non carborundum", a phrase originated during World War II, which we can render as "don't let despicable persons grind you down". Of course, no use of carborundum as a verb is legitimate Latin, because carborundum is a noun, and not a gerundive of any verb. In any case, after this aphorism had been created, carborundum found its place in the popular culture too.

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