PATENTABLE SUBJECT [ANTI]MATTER

Whether antihydrogen qualifies as patentable subject matter for the purposes of the United States patent law is not an easy question. In general, man-made inventions and new compositions of matter are proper subjects of patent protection, while products of nature are not. Antihydrogen, a newly created element made entirely of antimatter, has qualities of both a newly created composition of matter and a product of nature. As a result, antihydrogen approaches the theoretical boundaries of the product of nature doctrine because mankind finally has the opportunity to create *for the very first time an* element *that has probably never existed before in the entire universe. This iBrief will begin by briefly explaining antimatter and antihydrogen. Then, a distinction will be drawn between a man-made invention and a product of nature by analyzing relevant case law. Finally, antihydrogen will be analyzed as hypothetical subject matter under the United States patent laws without considering the further requirements of novelty and non-obviousness.*

An Overview of Antimatter and Antihydrogen

Antimatter

In 1930, the theoretical physicist Paul Dirac predicted that for every particle of matter, there exists an equivalent particle of antimatter.[1] The existence of antimatter was confirmed in 1933 with the discovery of the positron, the antimatter pair of the electron.[2] The theory does not mean to say that every proton in the universe must have a ghostly antiproton pair; rather it simply means that matter in the universe can be made of "real" matter, like protons and electrons, or it can be made of antimatter, like antiprotons and positrons. Theoretically, there should be no difference between the two possibilities. Each antiparticle has the exact same physical and chemical properties as the equivalent antiparticle with one exception: they carry the exact opposite charge.[3]

When a particle of matter collides with its corresponding antiparticle, they are both annihilated, releasing an intense burst of energy, usually in the form of light, according to

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[1] CERN–European Organization for Nuclear Research, *Why is Antihydrogen Interesting?, at* http://athena.web.cern.ch/athena/ (last modified Sept. 13, 2002); *see also* CERN–European Organization for Nuclear Research, *Antimatter Decelerator–The Story*, *at* http://cern.web.cern.ch/CERN/Announcements/2000/AD/story.html (last modified Aug. 8, 2000).
[2] *Id.*
[3] Tom W. Hijmans, *Cold Antihydrogen*, 419 NATURE 439 (2002); *see also* R. Michael Barnett & Helen Quinn, *What is Antimatter?*, *at*

Einstein's equation $E = mc^2$. Likewise, matter and antimatter can be created in equal amounts from energy according to the same equation.[4] Physicists use this property to create antimatter in particle accelerators. Particle accelerators use powerful electromagnets to accelerate charged particles to very high speeds and collide them with other particles. The energy of the violent collisions is transformed into pairs of particles and antiparticles.[5]

Similarly, particles and antiparticles are always being created in nature. A constant shower of particles and antiparticles rains from the sky as cosmic rays crash into earth's atmosphere. Cosmic rays are simply charged particles traveling near the speed of light. At that speed, they carry a great deal of energy, which is transformed into matter and antimatter in the violent collision with the atmosphere.[6]

There seems to be something unreal or surreal about antimatter's tendency to annihilate matter. The term "antimatter" is confusing because it implies the absence or nonexistence of matter. However, the difference between "real" matter and antimatter is not the difference between something "real" and something "imaginary". Antimatter is real, and the term itself is a misnomer. Antimatter, like matter, is a fundamental constituent of the universe. Antimatter exists and interacts in the universe. It has real substance and form and it has real, observable effects on the universe. Moreover, antiparticles, like particles, are fundamental building blocks of more complex material.[7]

Nevertheless, the relative scarcity of antimatter makes it exotic in the layman's mind. By a minute quirk of nature, everything that people interact with on a daily basis is made of "real" matter: elements made of protons, neutrons, and electrons. In theory, everything on Earth could be recreated with antimatter, and life would continue substantially unaltered. But, the Earth is made entirely of matter; in fact, the entire universe is made of matter.[8]

Physicists studying antimatter are trying to understand, among other things, why the universe is predominantly made of matter. Because all matter was created from energy at the

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http://www.sciam.com/askexpert_question.cfm?articleID=000848AB-9450-1CD1-B4A8809EC588EEDF&catID=3&topicID=13 (Jan. 24, 2002).

[4] *Antimatter Decelerator*, *at* http://cern.web.cern.ch/CERN/Announcements/2000/AD/story.html#6 (last modified Aug. 8, 2000); *see also* Barnett & Quinn, *supra* note 4.

[5] *Antimatter Decelerator*, *at* http://cern.web.cern.ch/CERN/Announcements/2000/AD/story.html#9 (last modified Aug. 8, 2000).

[6] *See Antimatter Decelerator, supra* note 6.

[7] *See* Barnett & Quinn, *supra* note 4; *see also* CERN, *Why is Antihydrogen Interesting?, supra* note 1; *Antimatter Decelerator, supra* note 6.

[8] *See* Barnett & Quinn, *supra* note 4.

beginning of the universe, during the "big bang", and because matter and antimatter are always created in equal amounts, the natural conclusion is that there must be an equal amount of matter and antimatter in the universe.[9] Instead, several lines of evidence indicate that the conclusion is not true. When astronomers look out into space and see galaxies made of matter colliding with other galaxies, they do not see the intense bursts of light that would result from annihilation. Consequently, for there to be a significant amount of antimatter in the universe, galaxies made of antimatter would have to be segregated from galaxies made of matter. Physicists know that this segregation is impossible because the universe evolved from a dense state where all matter was distributed evenly.[10] Alternatively, even if matter and antimatter did manage to segregate into separate galaxies, physicists would still expect to see intense bursts of light resulting from matter-antimatter annihilations at the edges of galaxies because a tenuous gas of elemental helium pervades nearly the entire universe.[11]

Antihydrogen

While antiparticles are created periodically in nature, more complex antimatter, like anti-atoms were unheard-of until recently.[12] Antihydrogen, the simplest "anti-"element, was created for the first time in 1995 by scientists working at CERN, the European Laboratory for Particle Physics near Geneva.[13] Antihydrogen is the antimatter equivalent of elemental hydrogen composed of one positron orbiting one antiproton. To create the anti-element, scientists directed a beam of antiprotons, traveling near the speed of light, at a stream of xenon atoms inside a particle accelerator. Infrequently, some of the kinetic energy of the antiprotons was transformed into electron-positron pairs as the antiproton collided with the xenon nucleus. Rarely, one of the positrons was traveling in the same direction of the antiproton at the same speed, and the two formed an atom of antihydrogen. The occurrence happened only nine times during the experiment, and each anti-atom lasted less than 40 nanoseconds before annihilating on the walls

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[9] *See Id*.

[10] *See* Steve Naftilan & Scott Dodelson, *How Do We Know that Distant Galaxies are Composed of Matter Rather than Anti-Matter?*, *at* http://www.sciam.com/askexpert_question.cfm?articleID=000858A0-76FD-1C72-9EB7809EC588F2D7&catID=3 (Oct. 21, 1999).

[11] *See* Evan Scannapieco et al., *The Emptiest Places*, SCIENTIFIC AMERICAN, October 2002, at 56; *see also Observations of Primordial Helium Illuminate Structure of Early Universe*, http://www.sciam.com/article.cfm?articleID=000A332B-9C8A-1C60-B882809EC588ED9F&pageNumber=1&catID=1 (Aug. 14, 2001).

[12] *See* Alexander Hellemans, *Through the Looking Glass*, 406 NATURE 556 (2000); *see also* Anette Pahl et al., *Antihydrogen at the MPQ: Introduction*, http://www.mpq.mpg.de/~haensch/antihydrogen/introduction.html (March 20, 2000).

[13] Hellemans, *supra* note 13, at 556.

of the facility. The antihydrogen atoms could not be studied because they were moving at 90% of the speed of light.[14] Then, in September of 2002, a team of physicists working at the Antiproton Decelerator facility at CERN announced the first controlled production of large numbers of antihydrogen atoms at low energies. At that time the experiment had produced about 50,000 antihydrogen atoms. The next step in the research is to trap and accumulate cold antihydrogen.[15]

For the purposes of this iBrief, assume that a similar process has never occurred before in nature. This is not an altogether unreasonable assumption. While conceivable, it is highly improbable that by random chance, an atom of antihydrogen could be created within an interstellar gas cloud in much the same manner as it was created by the scientists at CERN. The probability of creating an antihydrogen atom under the controlled conditions of the experiment was one in 100 million billion.[16] To create those "good" odds, the experiment required the following controlled conditions: (1) a high-energy antiproton beam (2) focused on a target of heavy atoms (xenon has an atomic weight of 131.3), (3) which creates an electron-positron pair (4) traveling in the same direction (5) at the same speed as the antiproton.[17] Moreover, this experiment was conducted in an evacuated chamber, and the motions of the particles were controlled by powerful electromagnets.[18] Evidently, the likelihood of the same thing occurring in an interstellar, or any other, gas cloud where the motions of the atoms are entirely random is negligibly small.

An alternative possibility, that an anti-atom was created very early in the formation of the universe, is also precluded. The first elements were formed roughly 300,000 years after the big bang when the cosmic microwave background radiation was emitted. Before that time, matter consisted of a hot plasma of ionized particles–no neutral atoms existed. Scientists know from the cosmic microwave background that the universe was dense and virtually uniform when it was emitted; therefore, it is reasonable to assume that any antiparticles existing before the elements were formed would have immediately annihilated within the dense soup of ionized matter.[19] Consequently, it is unlikely that anti-elements formed at the same time that elements did.

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[14] *Id*. at 557; *see also* CERN, *First Atoms of Antimatter Produced at CERN*, *at* http://www.washburn.edu/classes/hn/hn203/articles/AntiHydrogen.html (last modified Aug. 15, 2002).
[15] Hijmans, *supra* note 4, at 440.
[16] Research Center Jülich, *Antihydrogen Production*, *at* http://ikpe1101.ikp.kfa-juelich.de/ps210/home_english.html (last modified Dec. 9, 1997).
[17] CERN, *First Atoms of Antimatter, supra* note 15.
[18] *See* Hellemans, *supra* note 13.
[19] Douglas Scott & Martin White, *Cosmic Microwave Background–Introduction*, *at* http://www.astro.ubc.ca/people/scott/cmb_intro.html (last modified Feb. 10, 2000); *see also* *"First Light" Findings Reveal Seeds of Galaxy Clusters*,

Scientists are interested in antihydrogen for the same reason they are interested in antimatter particles. However, antihydrogen is a composite of fundamental particles with a new set of properties to study. Specifically, antihydrogen should absorb and transmit light exactly like hydrogen. These properties did not exist without the creation of an atomic structure; they are characteristic of an electron or positron bound in an atom. If scientists find that antihydrogen does not act exactly like hydrogen, they will know that matter and antimatter are not really mirror images of one another, and that, in turn, will help to explain how a universe composed almost entirely of matter could come to exist.[20]

Products of Nature

The Constitution grants Congress the power to pass laws that "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."[21] Patents offered to inventors of new and useful products grant the inventors the right to exercise a temporary monopoly over their inventions. The monopoly rents that society pays to these inventors are a reward designed to encourage innovative minds to produce a steady stream of new products and processes of manufacture.[22]

The breadth of patent protection authorized by Congress is evident in the language of 35 U.S.C. § 101, which provides that "whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefore, subject to the conditions and requirements of this title."[23] Limiting the broad language of § 101 are the requirements of novelty[24] and nonobviousness.[25] An invention is novel if it is previously unknown or undisclosed to the public,[26] and an invention is obvious if prior art or knowledge would lead a practitioner skilled in the art in which the invention was made to conceive of the invention and teach that practitioner how to accomplish the necessary steps of the invention.[27]

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http://www.sciam.com/article.cfm?articleID=000EBE39-691E-1CEE-93F6809EC5880000&pageNumber=1&catID=1 (May 24, 2002).

[20] Hellemans, *supra* note 13, at 558.

[21] U.S. CONST. art. I, § 8, cl. 8.

[22] Diamond v. Chakrabarty, 447 U.S. 303, 307 (1980).

[23] 35 U.S.C. § 101 (2000).

[24] 35 U.S.C. § 102.

[25] 35 U.S.C. § 103.

[26] *See* 35 U.S.C. § 102.

[27] *See* 35 U.S.C. § 103.

Despite the broad language of the statute, § 101 does not embrace every new product or discovery.[28] Patent protection does not extend to the laws of nature, physical phenomena or abstract ideas.[29] With respect to product patents, the product of nature doctrine has often imposed a bar to patent protection. The doctrine prevents geologists from patenting a mineral discovered in the earth and biologists from patenting a plant found in the wild.[30] It is simple to state that these discoveries are "manifestations of . . . nature, free to all men and reserved exclusively to none."[31]

Despite the simplicity of the concept, application of the doctrine has not always been straightforward. The label "product of nature" is not necessarily synonymous with a material that exists in or can be derived from nature; in fact, such products are frequently the objects of invention. The doctrine, perhaps, has been used to safeguard the requirement of an inventive step. In this respect, the doctrine often became tangled with the concepts of novelty and obviousness.

Sometimes, the label "product of nature" has been used to explain why an invention or discovery was obvious or lacked novelty.[32] For example, the patent in question in *Funk Brothers Seed Co. v. Kalo Inoculant Co.* covered a mixture of naturally occurring bacteria used to inoculate a wide variety of leguminous plants.[33] Prior to the invention, the beneficial properties of the bacteria were well known, but the individual species were also known to inhibit one another. Typically, individual inoculants had to be matched to a specific variety of leguminous plant.[34] When the inventor discovered strains of the multiple bacteria that had no inhibitive effect on one another, he mixed them creating an incredibly useful and generally applicable inoculant.[35] Nevertheless, the patent was invalidated on the ground that it covered a product of nature. All of the beneficial and non-inhibitive properties were clearly derived from the natural environment, and the court held that the aggregation of those bacteria and their collective benefits was an obvious application of a natural principle.[36]

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[28] *Chakrabarty*, 447 U.S. at 309.
[29] *Id.*
[30] *Id.*
[31] Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U.S. 127, 130 (1948).
[32] *See Funk Bros.,* 333 U.S. at 131-32.
[33] *Id*. at 128.
[34] *Id*. at 129.
[35] *Id*. at 130.
[36] *Id*. at 132.

Likewise, courts have cited evidence of novelty or non-obviousness to defeat the argument that a patent was granted on a product of nature.[37] In *Merck & Co. v. Chase Chemical Co.*, a patent for purified vitamin B-12 survived a challenge on the grounds that it was a product of nature.[38] Vitamin B-12 is useful as a treatment for pernicious anemia.[39] The vitamin occurs naturally in the liver of cattle, and before it was isolated, patients were treated by adding substantial quantities of liver to their diets.[40] The inventors were the first to isolate the vitamin in crystalline form from the fermentation products of a specific fungus and identify it as a B-vitamin. Afterward, it was shown that this fermentation product was the same compound that could be extracted and isolated from the liver of the cattle.[41] In rejecting the argument that the B-12 vitamin was not patentable as an object of nature, the court noted first, that the identity of the anti-pernicious anemia factor was unknown before its isolation and second, that the inventors were the first to make the treatment available to the world.[42] Both facts are evidence of novelty.[43] The court also drew attention to the fact that the prior art was directed at the study of the anti-pernicious anemia factor in liver,[44] which tends to show that the invention was non-obvious.[45]

While these arguments show the effort involved in invention, they do not fully illuminate the distinction between a true product of nature and a product merely derived from nature. The arguments do not fully explain why the label "product of nature" does not necessarily attach to a vitamin essential for life, or to DNA, or to microorganisms, all of which have been patented. Nor do they explain the distinction between a compound purified from an animal's organ, which is patentable, and an element purified from ore, which is not. In light of the delicate distinctions to be made, it is no wonder that the court in *Dennis v. Pitner* declared:

> The statements, "The laws of nature," "the principles of nature," "the fundamental truths," etc., are not patentable, have been oft repeated but seldom understandingly used. They have led to misunderstanding and much confusion, not limited to members of the bar. In fact, the words… are all words of broad and also elastic meaning and are frequently used carelessly and without any attempt at refined distinctions.[46]

A fresh perspective on the product of nature doctrine would be helpful.

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[37] *See* Merck & Co. v. Chase Chem. Co., 273 F. Supp. 68, 83 (D.N.J. 1967).
[38] *Id*. at 83.
[39] *Id*. at 70.
[40] *Id*. at 72.
[41] *Id*. at 83.
[42] *Id*.
[43] *See* 35 U.S.C. § 102.
[44] *Merck*, 273 F. Supp. at 83.
[45] *See* 35 U.S.C. § 103.
[46] Dennis v. Pitner, 106 F.2d 142, 145 (7th Cir. 1939).

The Supreme Court reached the issue in the landmark case *Diamond v. Chakrabarty*.[47] Faced with the question whether a human-engineered microorganism was a product of nature, the Court established that the inquiry was one wholly separate from the concerns of novelty and obviousness. The court stated, "[s]pecifically, we must determine whether respondent's micro-organism constitutes a 'manufacture' or 'composition of matter' within the meaning of the statute,"[48] and included the note, "[t]his case does not involve the other 'conditions and requirements' of the patent laws, such as novelty and nonobviousness."[49] The court thus asked the clear question: whether the object being patented is a material that is open for invention. In this regard, the Court reiterated the broad scope of 35 U.S.C. § 101 and accepted that statutory subject matter was intended to include "anything under the sun that is made by man."[50] From the Court's analysis, the relevant distinction is between "products of nature, whether living or not, and human-made inventions."[51]

Interpreting product of nature cases in this light, beginning with *Chakrabarty*, is particularly revealing. First, patentable subject matter includes an object or material that is engineered or created by man and, as a whole, is nonexistent in nature. The patent in *Chakrabarty* covered a microorganism that had been genetically engineered to break down the many components of petroleum into simple hydrocarbons.[52] Similar naturally occurring microorganisms existed that could break down single components of the crude oil, but those organisms could not live for long immersed in the many components for which they had no ability to decompose.[53] The advance made by the inventor was to engineer a new species of microorganism that carried the genetic material, and thus the unique abilities of decomposition, from two or more species that decompose petroleum. The process required complicated methods to identify and isolate beneficial sections of the organisms' genetic code and insert those snippets of DNA into the host organism.[54] As a result, no other microbe existed in the world with this unique combination of genetic information. This made the microorganism much more successful than naturally occurring microbes at surviving in and decomposing petroleum.[55] The Court called

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[47] *Chakrabarty*, 447 U.S. at 307.
[48] *Id*. at 307.
[49] *Id*. at 307 n.5.
[50] *Id.* at 309, quoting S. Rep. No. 1979, 82d Cong., 2d Sess., 5 (1952).
[51] *Id*. at 313.
[52] *Id*. at 305
[53] *Chakrabarty*, 447 U.S. at 305, n.2.
[54] *Id*. at 305, n.1.
[55] *Id*. at 310.

the new microorganism a "nonnaturally occurring manufacture or composition of matter—a product of human ingenuity."[56]

The microorganism was plainly crafted by man rather than by nature, yet an equally important distinction was made on the facts of the case: a patentable man-made invention has properties and qualities not found or replicated in similar natural materials. In *Chakrabarty*, the single new microorganism had acquired the abilities of other microorganisms along with a life expectancy exceeding that of similar organisms when immersed in petroleum. The patentee thus produced a new microorganism with "markedly different characteristics from any found in nature."[57]

Continuing to distinguish products of nature from man-made inventions, a specific mixture or composite material is patentable when new or refined properties arise from the combination of raw materials. The patent at issue in *Treibacher Chemische Werke Gesellschaft Mit Beschrankter Haftung v. Roessler & Hasslacher Chemical Co.* involved a pyrophoric alloy of cerium alloyed with iron.[58] Cerium is a metal that, when abraded, gives off particles that self-ignite in the air. After discovering that this quality depended on impurities such as iron, the inventor set about ascertaining the best combination of cerium and iron to achieve the maximum pyrophoric effect. The patent covered this specific alloy. In validating the patent, the court observed that any composition of matter has inherent natural properties; nevertheless, man must first produce the composite material before its special qualities may be known and used.[59]

Effectively, the alloy was patentable because the inventor identified a useful property and composed the material in a specific way as to achieve and refine that property. In contrast, a mixture that merely aggregates the properties of several natural products may not be patented. Recalling the mixture of bacteria in *Funk*,[60] the inventor had patented a product of nature because he merely aggregated several species and their particular qualities into one product. The court called the improvement "hardly more than an advance in the packaging of the inoculants."[61] The strains of bacteria accomplished nothing as a mixture that they would not accomplish alone in nature. They infected the same plants for the same use without any improvement of their utility.[62]

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[56] *Id*. at 309.
[57] *Id*. at 310.
[58] Treibacher Chemische Werke GmbH v. Roessler & Hasslacher Chem. Co., 214 F. 410 (S.D.N.Y. 1914).
[59] *Id*.
[60] *Funk Bros.*, 333 U.S. at 127.
[61] *Id*. at 131.
[62] *Id*. at 131.

Consequently, the mixture was not patentable subject matter.[63] Perhaps, the idea is that the sum must be more than its parts.[64]

Finally, a subtle difference between a man-made invention and a product of nature may be illuminated by a fine distinction between a chemical compound and a chemical element. To begin, a chemical compound extracted or purified from a natural material is patentable. Consider the patent, discussed above, covering purified vitamin B-12 in *Merck*.[65] Pure vitamin B-12, which could be isolated from cattle liver or the fermentation products of certain fungi, was held to be patentable.[66] Before it was isolated, it was unknown to the world and available to no one. Likewise, various compositions of B-12 of varying purity were patentable.[67] Each of the various compositions had specific B-12 concentrations and specific chemical activities or medicinal properties.[68] In each case, the anti-pernicious anemia qualities of the chemical compound remain unchanged, but the quantitative representation of those properties varies according to the design of the patentee.[69] Perhaps that is the effect harnessed by the inventor that defines the compositions as man-made inventions.

Strikingly, the same does not hold true for the chemical elements. An element is not patentable because its qualities are inherent and defined by nature alone. For example, in *General Electric Co. v. De Forest Radio Co.*, a patent for elemental tungsten was held invalid as covering a product of nature.[70] Tungsten, as it is found in the earth, exists as an oxide, meaning that it is combined with oxygen. In this state, tungsten is very brittle. The inventor devised a method of working the tungsten to release the oxygen resulting in substantially pure tungsten. Having been purified, the tungsten was ductile and capable of being drawn into a wire like other metals, and as a wire, tungsten is the filament of choice for electric light bulbs.[71] Nevertheless, the qualities of the metal, while wholly different from the impure oxide, were the natural qualities of pure tungsten.[72] The tungsten that the inventor uncovered was the "tungsten of nature"[73] in that nature was solely responsible for its creation as an element and for its qualities. Consequently, it cannot be patented.

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[63] *Id*. at 132.
[64] *See Chakrabarty*, 447 U.S. at 310.
[65] *Merck*, 273 F. Supp. at 70.
[66] *Id*. at 83.
[67] *Id*. at 89-90.
[68] *Id*. at 71.
[69] *Id*.
[70] General Electric Co. v. De Forest Radio Co., 28 F.2d 641, 643 (3rd Cir. 1928).
[71] *Id*. at 642.
[72] *Id*. at 642-43.
[73] *Id*. at 642.

Antihydrogen as a Product of Nature

The question presented is whether antihydrogen is a new composition of matter for the purposes of 35 U.S.C. § 101. The easy question is whether antihydrogen is patentable, and the trivial answer is "no."[74] Like many scientific discoveries, the creation of antihydrogen was published long before there was a commercial use for it.[75] Nonetheless, the analysis of whether antihydrogen is appropriate subject matter for a patent, whether it is a man-made invention or a product of nature, is intriguing because it presents a unique opportunity to study the results at the edge of the product of nature doctrine. Mankind finally has the singular opportunity to *create* for the very first time an *element* that has probably never existed before in the entire universe. The situation begs the question whether antihydrogen should be patentable or whether it should be considered part of mankind's common heritage.

First, antihydrogen is like a man-made invention because it probably would not exist but for the engineering of man. Like the microorganism in *Chakrabarty,*[76] an atom of antihydrogen did not previously exist in nature. That is not to say that nature did not facilitate its existence; it is possible for antihydrogen to exist in nature, just like it must have been possible for the microorganism to exist, else it would not have been invented. Nevertheless, it is unlikely that a positron and an antiproton have ever come together on their own to form antihydrogen. As a result, man has intervened to artificially manufacture the antiatom. Like the DNA of the microorganisms in *Chakrabarty*, the raw materials of the antihydrogen atom, antiprotons and positrons, must be assembled by a complicated man-made process. The antimatter particles are generated and combined in particle accelerators using enormous amounts of energy and complicated electromagnets and computer systems. Thus, the antihydrogen may be called a "nonnaturally occurring manufacture or composition of matter—a product of human ingenuity."[77]

Moreover, antihydrogen is like the *Chakrabarty* bacterium because it has emergent properties wholly different from those of its constituent particles. In short, the antihydrogen atom is greater than the sum of its parts. For example, antihydrogen should bond to other anti-atoms just like hydrogen bonds to other atoms, and physicists want to study the absorption spectrum of antihydrogen atoms, which is a property of its atomic positron, rather than a free positron. These properties only exist once scientists bring the antiproton and positron together to form an anti-atom.

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[74] *See* 35 U.S.C. § 102.
[75] *See Antihydrogen–A New Energy Source?*, *at* http://ikpe1101.ikp.kfa-juelich.de/ps210/home_english.html (last modified Dec. 9, 1997).
[76] *Chakrabarty*, 447 U.S. at 310.
[77] 447 U.S. at 309.

On the other hand, those "emergent" properties were dictated not by the design of man, but instead, by that of nature. Antihydrogen is more like a product of nature because it is the antimatter equivalent of an element. As an element, like tungsten, man cannot engineer, select or enhance its properties; instead, the qualities characteristic of antihydrogen are inherent in its nature.[78] Most likely, antihydrogen will react and behave exactly like hydrogen. The laws of physics define those properties, and the scientists creating the antihydrogen atoms are merely discovering the natural properties of the substance, like the inventor who first purified tungsten from its natural ore. Those scientists cannot really tailor the properties of antihydrogen to their liking, as Chakrabarty did with his bacterium.[79] Yet in one important respect, antihydrogen is unlike the purified tungsten in *General Electric*: there has never been a *natural source* of antihydrogen from which it can be purified.

Because antihydrogen never existed in nature, perhaps the analysis in *General Electric*[80] is not binding. Instead, antihydrogen is unlike the chemical elements because man gets to exploit the natural, or inherent, properties of the substance through an act of creation.[81] The tungsten in *General Electric* existed *in nature* to be purified, and so its chemical and physical properties, which inhered in the tungsten, must also have existed in nature. In contrast, antihydrogen as a complete element probably never existed at all, in which case it cannot be purified in order to discover its properties. How, then, can properties which inhere in their source exist without that source? Since there is no natural source of antihydrogen, its properties cannot be "inherent" in the same way that the properties of the chemical elements are inherent. Antihydrogen must first be created.[82] Therefore, the creator of antihydrogen cannot be said to have simply discovered its natural properties, as did the inventor who purified elemental tungsten.[83] That is not to say that the properties cannot be predicted, but standing alone, the successful prediction of the properties of a future invention cannot possibly be a bar to patentability.

Conclusion

For the purposes of patentability, products of nature tend to be compositions of matter that can be taken directly from the environment and put immediately to use. Products of nature are not patentable. The chemical elements fall into this category, even though they may be difficult to isolate, because they are fundamental building blocks of the natural world. In theory,

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[78] *See General Electric*, 28 F.2d 641.
[79] *Chakrabarty*, 447 U.S. at 305.
[80] *See General Electric*, 28 F.2d 641.
[81] *See Treibacher Chemiche*, 214 F. 410.
[82] *See Id*.

antimatter elements are as fundamental to nature as are the elements, being the building blocks of a mirror-image world, but they may be classified differently for patent purposes.

Antimatter elements may qualify as man-made inventions rather than products of nature. Our universe is one made of matter, and it is very likely that the antimatter elements exists nowhere in nature. As a result, antimatter elements do not exist but for the sophisticated processes of creation engineered by scientists. The properties of the anti-elements can be predicted because they are defined by well-know physical principles, but before those properties can be put to use, the anti-elements must be created from scratch. As a result they may fall within the scope of the United States patent laws as new manufactures or compositions of matter. Whether they turn out to be useful is an open question.

By: Kristoffer Leftwich

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[83] *Compare General Electric*, 28 F.2d 641, *with Treibacher Chemiche*, 214 F. 410.