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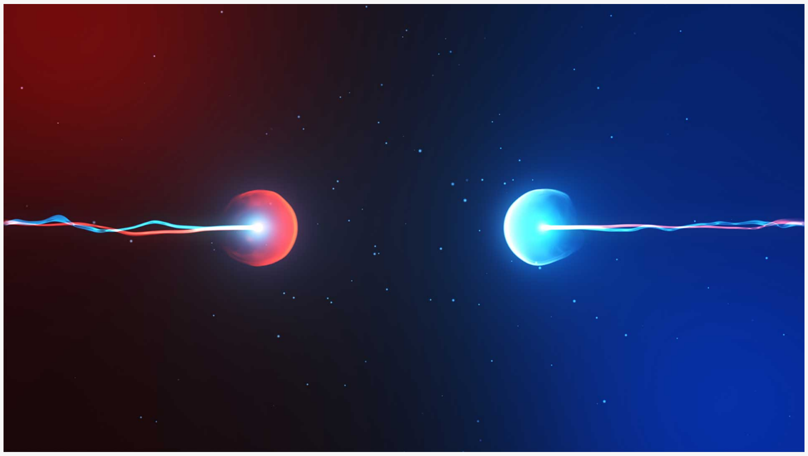
Boron and Nuclear Fusion

Boron could be the key to getting beyond the lab and into the real world. Scientists have been looking ways to capture energy in order to provide green energy.



Boron and Nuclear Fusion

NEW YORK, NEW YORK, USA, April 13, 2022 /EINPresswire.com/ -- Producing large-scale sustainable energy by nuclear fusion of hydrogen and other very light nuclei similar to the energy source of the galaxy is the holy grail for many scientists.

Sixty years of worldwide research for the ignition of the heavy hydrogen isotopes deuterium (D) and tritium (T) have provided near breakthroughs for ignition. However, DT fusion produces radioactive waste.

However, one clean fusion process – without neutron production – is the fusion of hydrogen (H) with the boron isotope 11B11 (B11). Boron 11 plays a vital role in creating the conditions necessary to release energy in fusion experiments.

Borates Today has chosen three research projects which show different approaches to using Boron in the quest for nuclear fusion.

Fusing Protons and Boron11 Nuclei using Lasers (2013)
In 2013, physicists at the CNRS laboratory succeeded in producing fusion at an accelerated rate in the laboratory led by Christine Labaune, research director of the CNRS Laboratory for the Use of Intense Lasers in France.

Previous laser experiments generated boron fusion by aiming the laser at a boron target to initiate the reaction, which provided low levels of energy but the infrastructure needed to provide energy meant that any commercalisation would require more energy to create the energy than that produced.

Labaune claims the laser-generated proton beam in her setup produces a tenfold increase of boron fusion because protons and boron nuclei are smashed together directly.The two-laser system fuses protons and boron-11 nuclei.

One laser creates a short-lived plasma, or highly ionized gas of boron nuclei, by heating boron atoms; the other laser generates a beam of protons that smash into the boron nuclei, releasing slow-moving helium particles but no neutrons. The researchers describe their work in Nature Communications today.

Lasers have previously been used to crush a tiny pellet of two hydrogen isotopes — deuterium and tritium, containing two and three neutrons, respectively — to the point of initiating fusion. But in addition to producing neutron radiation, crushing the pellet evenly for the reaction requires a large array of lasers — there are nearly 200 at the world's largest laser, the National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory in California.

If the boron-fusion method were successfully scaled up, "we expect that it will reduce significantly the total laser energy" needed compared with that used at NIF, says Labaune.

Timing was crucial for the success of the experiment, says study co-author Johann Rafelski, a theoretical physicist at the University of Arizona in Tucson.

The boron plasma generated by the laser lasts only about one-billionth of a second, and so the pulse of protons, which lasts one-trillionth of a second, must be precisely synchronized to slam into the boron target.

The proton beam is preceded by a beam of electrons, generated by the same laser, that pushes away electrons in the boron plasma, allowing the protons more of a chance to collide with the boron nuclei and initiate fusion.

Mourou's study is not targeting ignition, the holy grail, but trying to make the study practical so it can be commercialized as a future power source.

HB11 fusion for a reactor may be used instead of the DT option. Several key research studies summarised below show how scientists are making significant progress in accelerating the ability to harness power through hydrogen boron fusion.

Studies into Laser Beam Ignition of Boron-hydrogen Fusion (2017)
According to studies done and published here, the road map to clean energy using laser beam ignition of boron-hydrogen fusion follows this process: process is as follows:
Acceleration of a plasma block with a laser beam with the power and time duration of the order of 10 petawatts and one picosecond accordingly;

A plasma confinement by a magnetic field of the order of a few kiloteslas created by a second laser beam with a pulse duration of a few nanoseconds (ns);

The highly increased fusion of HB11 relative to present DT fusion is possible due to the alphas avalanche created in this process;

The conversion of the output charged alpha particles directly to electricity;
To prove the above ideas, simulations in the lab show that 14 milligram HB11 can produce 300 kWh energy if all achieved results are combined for the design of an absolutely clean power reactor producing low-cost energy.

2022 Generating Power with Boron and Giant Lasers
HB11 Energy raises US$20m to develop laser fusion process using boron

HB11 Energy, an Australian start-up, has completed ground-breaking laser experiments which can potentially provide limitless electrical power generation via nuclear fusion.

Sydney start-up HB11 Energy, which is launching its own $US20 million capital raise to help develop its fusion process, is working with Japanese researchers in Japan who give access to the petawatt-class laser needed for fusion experiments. There are only a few lasers available right now which can provide this level of energy needed to carry out the experiment.

HB11 Energy's approach uses the laser beam to smash hydrogen atoms into boron, which produced a nuclear fusion reaction. The resulting energy released, albeit in small amounts today, may be stabilised and converted to electricity.

What's more, this is a safer approach than current nuclear energy procedures. Traditional nuclear reactors, or fission reactors, split larger elements such as uranium, into smaller elements. This releases energy together with radiation and plutonium, which takes a very long to tie to degrade. None of these negatives are found in the fission process using laser with boron and hydrogen.

In the case of HB11, the smaller elements of hydrogen and an isotope of boron – boron-11 -, are smashed together under extreme pressure. The new element formed releases energy but any waste created has a very short afterlife. Also, there is no radiation released.

According to an expert in the field who has been working on laser-ignited fusion since the 1960s, Professor Henirich Hora, (also involved with HB11 Energy), the positive charge is harvested to produce electricity and helium gas, which makes it an ideal technology for de-carbonising the electricity grid.

Using just 3.4kg of boron, the fusion process with hydrogen, when commercialised, has the potential to meet the power needs of an individual for their entire lifetime. The boron reserves of the world's largest producer, Eti Maden, estimated to be over 1 billion tonnes, could power the planet for about 3,000 years.

Despite the promise of a new source of safe and clean energy, research into fusion has been going on for decades and some scientists believe it is as far away from commercialisation as ever.

Dr Daniele Margarone, a laser acceleration physicist at the Queen’s University Belfast who collaborated with HB11 on its latest fusion experiment, described the results as a “big step forward, not a breakthrough”.

Results of the experiment were published in January, in the peer-reviewed journal Applied Sciences.

“For the first time, a large amount of proton-boron fusion reactions were demonstrated using a short pulse laser . . . that can be potentially scaled up at large laser fusion facilities using an approach known as fast ignition,” Dr Margarone said.

“There was no similar experiment done earlier, so this new approach could open a new research field for future net energy production.”

Net energy production, where the energy gathered from the fusion reaction is more than the energy required to ignite the reaction in the first place, is one of stumbling blocks for the fusion industry.

Commercialising laser facilities which require petawatts of power can be as large as a football stadium, which in itself will require more power than that generated from the reaction

Before we can look at real progress to net energy gain, Dr McKenzie estimates HB11 needs to produce around 10,000 times more power from hydrogen-boron fusion than current experiments.

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