

Diamonds and Nuclear Technology – Is it Love?

In a previous article, “Let’s have a Date... by Nilormi Das” (read it here - <https://thebetterenergy.net/radioactive-dating>), we were all enlightened about how an isotope of Carbon (Carbon-14 or ^{14}C) is used in Radiocarbon Dating to determine the age of samples that are 30,000 – 40,000 years old. On Valentine’s Day this year, I realised that there is a serious “love connection” between Nuclear Technology and Carbon, both are serious with their relationship and wish to take it further. In this article, I highlight how Nuclear Technology and Diamonds (an allotrope of Carbon) are taking it to the next level.

The phenomenon by which an element can exist in more than one physical state is called allotropy. Diamond is the purest crystalline allotrope of carbon. We all know that Diamond is the hardest mineral/element and no naturally occurring substance can cut (or even scratch) a diamond, except another diamond. What is with this allotrope of carbon (Diamond) and Nuclear Technology? Let’s dig in!

Diamond Battery – Solution to Nuclear Waste?

Lately, a lot of research is taking place regarding the safe management and disposal of radioactive nuclear waste, and a very interesting research involves generation of electricity from nuclear waste in a nuclear-powered battery.

In 2016, researchers from the University of Bristol in the UK demonstrated a novel technology that used nuclear waste to generate energy. Their team of physicists and chemists have grown a man-made diamond that, when placed in a radioactive field, is able to generate a small electric current. Unlike majority of electricity generation technologies, the man-made diamond is able to produce a small electric current simply by being placed in close proximity to a radioactive source. Materials engineering professor, Dr. Tom Scott at the university says: “There are no moving parts involved, no emissions generated and no maintenance required, just direct electricity generation. By encapsulating radioactive material inside diamonds, we turn a long-term problem of nuclear waste into a nuclear-powered battery and a long-term supply of clean energy.”

In 2020, a California based startup, NDB, has developed a nano-diamond battery that they claim could last up to 28,000 years without charging. In this case, a Diamond Nuclear Voltaic (DNV) semiconductor device is responsible for charge collection. In this kind of device, the radioactive core is protected with multiple layers of synthetic or polycrystalline diamonds.

Professor Scott adds that these batteries could be used in situations where it would not be feasible to charge or replace conventional batteries. Some of the obvious applications would be in low-power electrical devices which require long life of energy source, such as pacemakers, satellites, high-altitude drones or even space applications.

Jewellery Applications and Coloured Diamonds!

Diamond is perhaps one of the most precious gemstones, very popular in the jewellery market. Fancy coloured diamonds are among the most highly sorted after gemstones. Scientists have been irradiating diamonds for over a century, it was Sir William Crookes who in 1904 discovered that diamond’s colour could be changed after being exposed to radium

salts.



Several irradiation alternatives are available today, the most common being neutron bombardment in a nuclear reactor. This results in stones of green to black colours, but if they are treated with heat after irradiation to temperatures between 500 °C - 900 °C then orange, yellow, brown or pink colours are obtained. Another technique to obtain coloured diamonds is by electron bombardment using Van de Graaff generators, which produces blue, blue-green or green coloured gems. Furthermore, if post irradiation heat treatment is carried out to temperature of 500 °C - 1200 °C then orange, yellow, brown and fancy pink colours are achieved. Less commonly used methods of colouring include proton and neutron bombardment via cyclotrons and gamma ray treatments.

Concluding Remarks

Diamonds are the way to a woman's heart and with recent developments in technology, they could also be a man's best friend.

The nuclear based radioisotope batteries involve no moving parts, zero maintenance and are just direct and continuous electricity generation devices. The power output of these diamond batteries is low when compared to other alternatives but despite that these show a huge potential with wide applications. Their longevity favours them to become critical components of future electronics. Also by encapsulating radioactive materials inside diamonds, it is possible to turn a long-term serious problem of nuclear waste management into a long term clean energy solution.

Irradiation of diamonds has been happening for ages. All diamonds have been exposed to natural radiation over the millennia before man unearthed them. Irradiated diamonds are treated only for the colour that means the overall clarity and/or the imperfections won't change with this process. Irradiated diamonds come in blue, green, canary yellow, pink as well as many other colours.

Finally, I hope this article has highlighted the serious "love connection" between Nuclear Technology and Diamonds!

References

1. <https://phys.org/news/2016-11-diamond-age-power-nuclear-batteries.html>
2. <https://www.electronicshobby.com/technology-trends/must-read/diamond-batteries-lasts-thousands-years>
3. <https://www.middiamonds.com/diamond-education/diamond-treatments-irradiation/>
4. <https://www.caratsdirect2u.com/Articles.asp?ID=278>