



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 10, October 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569

 9940 572 462

 6381 907 438

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# Applications of Graphene for a Sustainable Future

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**ABSTRACT:** Given the growing range of applications and importance of decisions based on the operations of removing toxins and the increased concern of security that grows with their spread, the topic of a sustainable future is one of global concern with an impending and lasting future. Its importance is obvious and demands research in its concern.

This research concentrates on the environmental damage caused by single use plastics and toxins and the efforts that have been made to combat that. The scope of this work focuses on the application of graphene in order to extract these wastes, from the implementations and utilization of graphene and the efforts that have been made and proposed in regards to these concerns. Several existing analyzes are to be discussed regarding the possible future looking forward to graphene.

**KEYWORDS:** Graphene, extraction, sustainability, environment, application.

## I. INTRODUCTION

The ever-growing environmental problems that we, as a society, are faced with are immeasurable. That's why it's necessary for us to be innovative and create ingenious solutions to them. The solution is a material that's not only the thinnest but also the strongest. One that's not only optically transparent but also so dense that helium ( the smallest gas atom) is unable to pass through it. One that conducts heat and electricity better than any material. One that's not only multiple times stronger than kevlar and diamond put together but is a fraction of the weight. Recently discovered in 2004, the material is called Graphene. It's amazing properties are endless and we've only just managed to scratch the surface.

Using these properties, new graphene technologies promise to offer solutions to environmental sustainability challenges. One of the major environmental issues that has gained traction over the past decade is the eruption of microplastics and metallic pollutants in water bodies. These toxins are found almost everywhere we're looking. Both microplastics and metallic pollutants are being found in oceans, lakes, waterways, soil, air, and unfortunately, even our food. This means that there's a pretty good chance that every one of us has some form of toxin inside our bodies. However, the ways in which graphene can solve this seems like a no-brainer not only in terms of its ingenuity but also its practicality.

## II. LITERATURE SURVEY

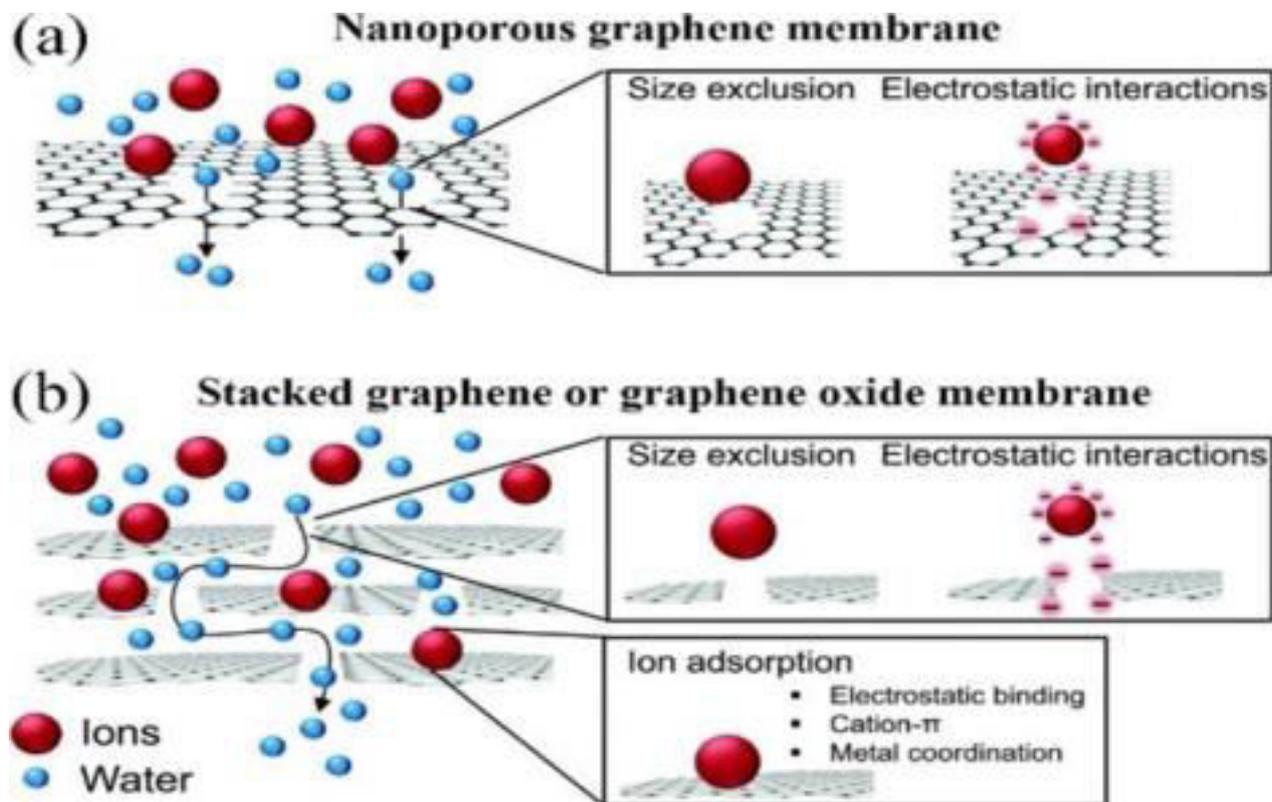
By creating sustainable materials with lower graphene use, the carbon footprint required to produce and integrate graphene for the intended applications can be significantly lower. Graphene can also be used as an addition to physical properties to improve the green properties of materials. In situ photocatalytic synthesis of AG nanoparticles (NAGs) and creased graphene oxide composites for membrane filtration and disinfection applications.

Graphene has a surface-stable and volume-conducting material with great potential for energy storage. In order to make other materials more sustainable and environmentally friendly, graphene can be produced using a process. This method converts organic waste (plastics, household waste and other carbon-based materials) into contamination-free graphene. Graphene has considerable potential to become a mass product. Due to its strength, it could be developed as a possible replacement for Kevlar in protective clothing used in vehicles and manufactured for use as a building material. Graphene is an advanced material that plays an enormous role in making our construction infrastructure not only greener, but also smarter.

### III. PROPOSED METHODOLOGY AND DISCUSSION

As mentioned earlier, the filtering properties of graphene are unparalleled. It has enormous potential to be used as a pipe-filter since it will act as an obstacle to the much larger plastic particles and stop them from entering the water bodies and will prevent damage to marine life. Moreover, since graphene is such a good conductor means it can be magnetised very easily. After coming in contact with an inductor, the carbon molecules instantly transfer the magnetic energy and turn the graphene into an electromagnet. This can remove the ever present water pollutants like mercury, tin and lead. Optimized graphene oxide foam has an affinity for metals and makes it particularly efficient for mercury removal from water. The high surface area and rich wealth of the material makes graphene oxide an attractive candidate for biotechnology and environmental remediation. These properties make graphene ideal for systems for pollutant monitoring, water treatment and desalination.

No other material today can compare the properties of graphene: its strength, electrical conductivity, thermal conductivity and surface filtration are unsurpassed. This book outlines important sustainable, recyclable and environmentally friendly methods for the innovative use of a range of graphene-based materials. We highlight current advances in research and application of graphene in the real world, focusing on energy, environment and antimicrobials.



Many existing water treatment technologies require capital and energy, but permeable graphene membranes could change this. Due to its high surface area, graphene acts as a good adsorbent for pollutant removal. Increasing graphene increases the adsorption of organic aromatic dyes by selective adsorption of aromatic regions. Graphene has the ability to operate as a superior membrane compared to conventional materials such as polymers and has the potential to reduce the consumption costs associated with the technology and increase productivity, while also doing the best job at cleaning water bodies.

The properties and extensive applications of graphene can be attributed to its unique physicochemical properties of high surface area, thermal conductivity, high adsorption capacity, chemical stability, high electron mobility and significant mechanical strength. It seems that graphene can reduce electrode resistance and reduce active material content to create batteries with high energy capacity and potential for high performance applications.

Due to their outstanding properties such as large surface area, size, mechanical strength, stiffness as well as electrical and thermal conductivity, the production of metal-coated graphene nanocomposites is an encouraging new material for removal of various pollutants from aqueous systems. The development of reduced graphene oxide aerogels that



generate effective G-radiation-induced self-assembly and their application to continuous oil-water separation. The dye decontamination ability of decorated graphene hydrogels is superior to that of other carbon-based materials such as metal and organic frameworks. Our research group developed novel solutions based on molecular principles of self-assembly to create multidimensional structures with nanoscale precision through concentrated GO dispersion, enabling easy spinning of graphene-based 3D printing and unprecedented applications of GO liquid crystal fibers emerging as the next generation of carbon-based fibers with multiple functionalities that complement those available in traditional carbon fibers. The use of additives for the various physical properties of graphene can reduce the application of these materials.

Macroporous three-dimensional graphene oxide foam for dye adsorption and antibacterial applications. The graphene family of nanomaterials is the most common class of carbon-based nanomaterials in electronics, medicine, energy use and environmental applications. Among the various commonly used materials, graphene nanocomposites with metal embellishment are the easiest to synthesize and manufacture and can be doped with various metal oxide nanoparticles.

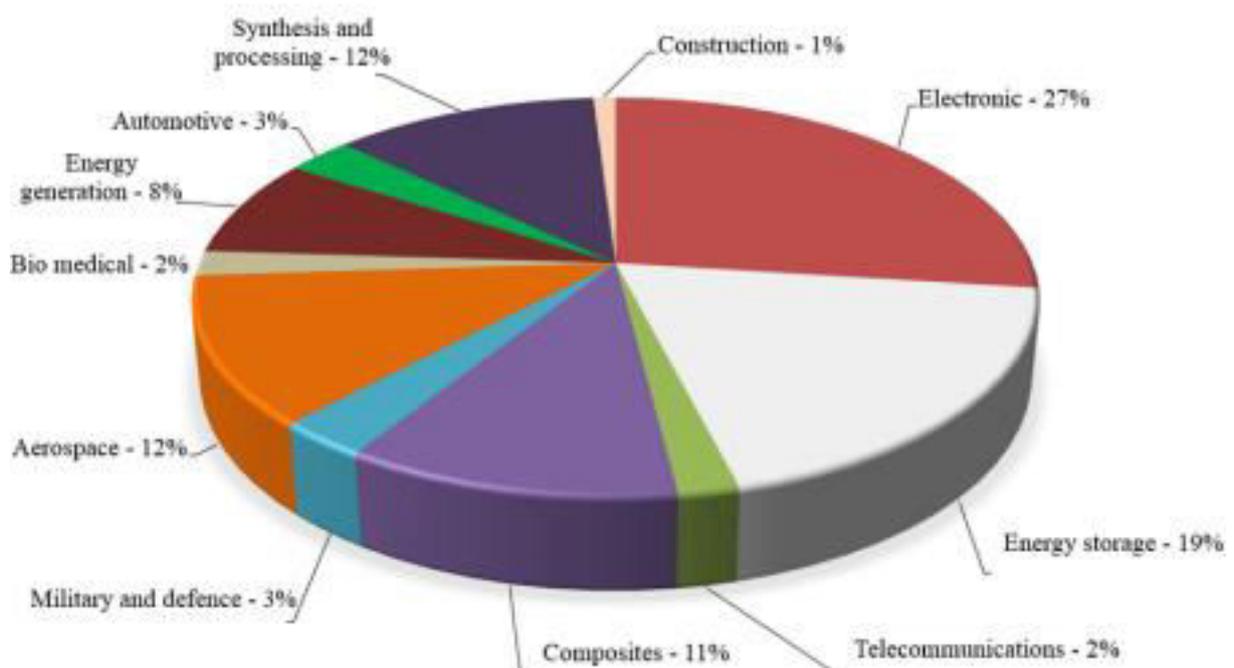
Oribayo O, Feng X, Rempel G-L, Pan Q. Synthesis of lignin-based polyurethane and graphene oxide foams and their applications for cleaning and recovering oil spills. Many speak of graphene for high-tech applications, but it is the basic applications of its use as an additive that bring it to market. Reduce electrode resistance while maintaining the active material content to create high energy batteries with incredible potential for high energy applications.

Optimized graphene oxide foam with improved performance and high selectivity for mercury removal from water. The high surface area and rich wealth of functional groups make synthesized graphene (also known as graphene oxide, GO, reduced graphene oxide (RGO) or transformed graphene) an attractive candidate for biotechnology and environmental remediation. These properties make graphene ideal for systems for pollutant monitoring, water treatment and desalination, as well as for improving battery and solar energy technologies.

From renewable energy generation to sustainable water sources, graphene has the potential to generate many disruptive technologies that open new markets and provide powerful solutions to many of today's environmental challenges. Hydrophobic ultralight graphene aerogel are highly efficient oil-absorbing materials. Production of three-dimensional graphene oxide and polyethylenimine porous materials for dyes and gas adsorbents.

Reusable superhydrophobic spongy graphene aerogels for efficient oil-water separation. Graphene can be mixed with asphalt materials used in road construction, which reduces the amount of material needed for production. The manual of three-dimensional graphene materials covers the synthesis and application of electrocatalysts and electrochemical sensors.

#### IV. EXPERIMENTAL RESULTS



Many existing water treatment technologies require capital and energy, but permeable graphene membranes could



change this. Graphene has the ability to operate as a superior membrane compared to conventional materials such as polymers and has the potential to reduce the capital, energy and the consumption costs associated with the technology and increase productivity.

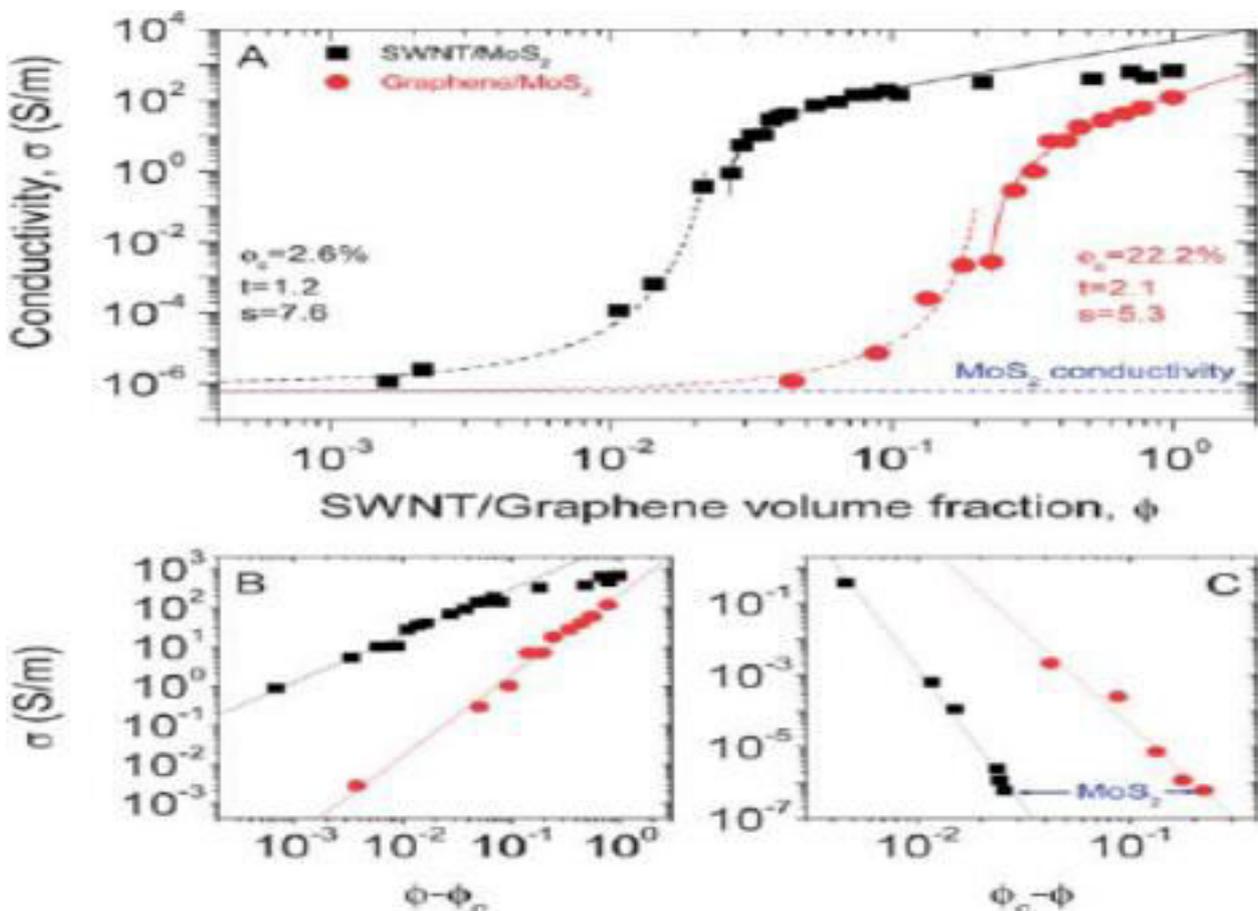
In general, the function of graphene can be divided into two aspects: its photonic and electronic properties. Graphene itself can be produced in an environmentally friendly way, without dangerous chemicals and extreme energy consumption.

The enhanced graphene increases the Adsorption of organic aromatic dyes such as MB for the selective adsorption of aromatic regions by p-P electron coupling. Metal NPS and 3D GBM act as good catalysts for converting graphene nanosheets with excellent support for abundant adsorbed reactants and uniform catalyst anchoring. Polyvinyl alcohol, Polyacrylic Acid (TIO), Graphene oxide (PVA), PAAC and TIO-GO nanocomposite hydrogels maintain over three consecutive cycles more than 90% of their photocatalytic activity without any slight decrease in photocatalytic activity.

Graphene technology enables single-stage desalination and ultrawater filtration. Graphene is the material researchers need to find solutions to our growing and expanding global community of the 21st century.

Two-dimensional materials such as graphene are materials with an atom thickness. For example, graphene is atom thick, the thinnest compound and the lightest material known to man, and it conducts electricity and heat effectively. As such a thin honeycomb of carbon atoms, graphene, the wonder material, is considered two-dimensional but is stronger than diamond, more conductive than copper and more flexible than rubber.

Graphene has the potential to generate numerous disruptive technologies that will open new markets and provide powerful solutions to many of today's environmental challenges from renewable energy to sustainable water sources. From graphene streets and buildings to graphene and its various derivatives, there are many ways to make our future cities more sustain



nable and our societies more developed. The most exciting properties, applications and possibilities make graphene the material of our time for civilization.

Moreover, graphene energy storage is not limited to battery-powered supercapacitors, which gain traction as a critical solution in conjunction with other energy storage systems. Graphene is not the only solution

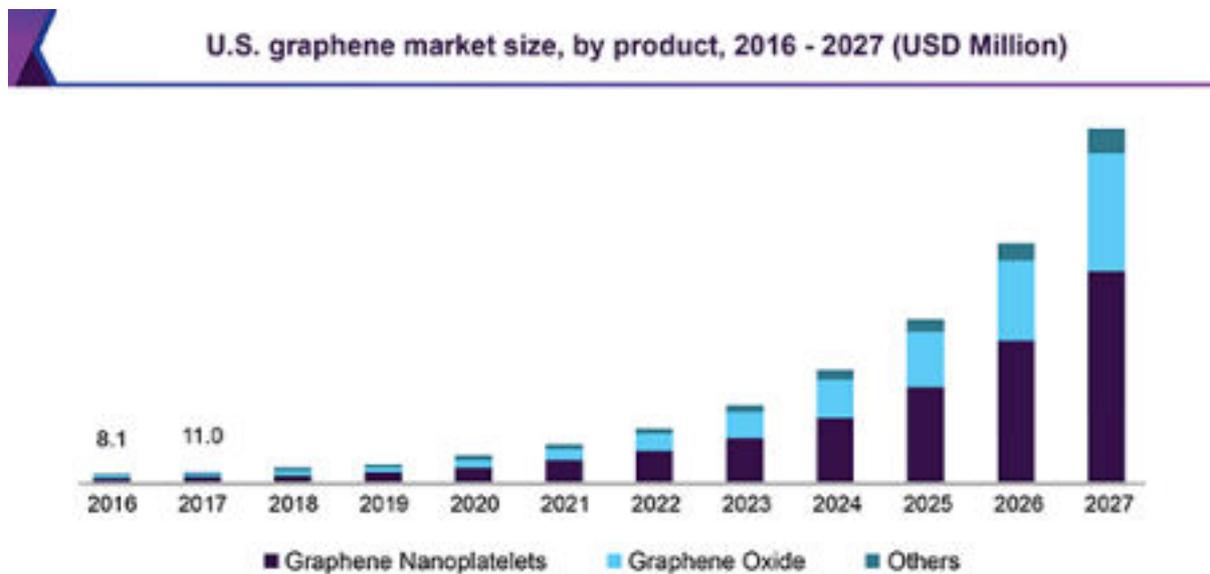


currently being explored, and if companies can find a suitable solution, it could be important for the industry. Researchers at the Graphene Flagship are also exploring ways to use graphene to improve energy production, including improvements to perovskite solar cells (PSCs), a promising next-generation, high-efficiency solar power source. At Graphene's flagship, researchers have made excellent progress in improving the lifespan and performance of PSCs and lowering the cost of producing cells.

Using graphene-related materials (GRM) as an intermediate layer, tandem cells in combination with PSC silicon cells from Enel Green Power and flagship partner Graphene achieved record stability and efficiency, as demonstrated by a PCE-Announced increase of nine percent in GRM-based perovskite silicon tandem cells compared to tandem cells without GRM.

The graphene flagship aims to lead the way by focusing on energy efficiency and replacing rare materials with conventional ones to ensure that its research is globally compatible. Other industry partners in the graphene-enabled high-energy battery for automotive applications (greenbat) are Varta Microbattery and Bedimensional (Varta Micro Innovations), which are developing battery technologies based on patented graphene manufacturing and silicon compounding processes. The project aims to improve battery technology for electric vehicles and help the EU reach its sustainability goals.

Large-scale production of low-cost, high-quality graphene using environmentally friendly methods from abundant raw materials is a crucial step towards widespread sustainable use of the material. There are a number of positive applications of graphene, including its use in solar energy and energy storage technologies to reduce electric costs and global dependence on fossil fuels, the use of graphene oxide as a material to remove pharmaceuticals and aqueous solutions, the use of graphene technologies for water treatment and the use of graphene composites to improve sustainability and protect steel from corrosion. It appears that graphene can reduce electrode resistance by reducing active material content, resulting in batteries with high energy capacity and potential for high performance applications. Graphene is a wonder material and a blessing for the age of technology and speed. Made from carbon, the chemical basis of all known life on Earth, it



Source: [www.grandviewresearch.com](http://www.grandviewresearch.com)

is an environmentally friendly and sustainable solution with an unlimited number of applications.

Graphene, drawn from graphite, is a polymer additive that has the advantage of competing with fossil fuel-based additives in sustainability. Due to the small size and structural properties of graphene, it can be integrated into multiple materials, making it more robust and lighter, and less material needs to be used to add them. It can be mixed with cement and concrete, and it can even be added directly to the asphalt used in our roads.

This effect is possible because small amounts of graphene can reduce the amount of cement needed for concrete, reducing the total amount of material produced and used. Graphene has the properties to make concrete stronger, but less material is needed to achieve the same effect. Its transparent, two-dimensional character and high conductivity has led developers to include graphene in the design of photovoltaic materials to improve the efficiency of solar power generation without the need for expensive rare earth materials.

For example, the Graphene Engineering and Innovation Centre, the flagship Advanced Materials Accelerator at the University of Manchester, is working on a series of projects with Highways England, the government agency



responsible for much of the nation's highway network, and Arcadis, a leading global design consulting firm, as well as Natural Build Assets. The Graphene Engineering & Innovation Centre is supported by partners such as Arcadiss and Highways to meet the challenges of building road networks.

## V. CONCLUSION

The turning point for graphene is that many manufacturers will not succeed, consolidation is inevitable, and multiple drivers for graphene will emerge as the value-added material of choice.

Now while these efforts towards a sustainable future do seem straightforward, there has been a major caveat when it comes to using graphene: its production. There's a reason why graphene hasn't become the "next revolutionary material" like plastic and why we don't see it being used by industries worldwide. Since its discovery in 2004 and thus far, one can argue that barely any progress has been made in manufacturing graphene on the biggest scale. Because graphene is such a relatively new material, it would be unreasonable for us to expect it to change our lives overnight.

In its simplest form, graphene is two dimensional and is only made up of a one atom thick carbon layer that's bonded very strongly. That's where the differences start to factor in already. Since its chemical makeup is unlike any material, scientists have found it difficult to mass produce graphene. That's not to say that we haven't gotten anywhere with producing graphene.

From isolating the material onto zinc tubes under extreme pressure to using sulfuric acid to dissolve it, there have been abundant ways in which efforts have been made to produce it. 3-D printing, however, has gained much popularity in terms of its efficiency. Researchers at the Massachusetts Institute of Technology, using a custom AM machine, printed various 3D objects from graphene and tested them to measure their physical properties compared with more conventionally produced parts. The results were astonishing. Some of the 3D-printed samples had 10 times the strength of steel at 1/20th the mass. They can now print parts and assemblies that may, in some cases, replace custom-manufactured steel parts.

To conclude, research and development continues to unveil an incredible set of properties that make graphene technology ideal for achieving environmental sustainability in the 21st century. Graphene is an environmentally friendly and sustainable solution with an unlimited number of applications and thus is proving to be a revolutionary solution to various worldwide environmental problems. All-in-all, this is just one of the various ways we can have a sustainable future by using this material. Graphene technology enables us to create wondrous solutions in our hunt for a sustainable future. It is the material researchers need to find solutions to our growing and expanding global community of the 21st century. It plays an enormous role in making our future not only greener, but also smarter. Different solutions are needed in each of these areas, and in many cases graphene is emerging as a contender to help our ecosystem become more sustainable and smarter.

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