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Original Article

Quantum Cloud

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Abstract - *Quantum computers are a new kind of machine that promises an exponential growth spurt in processing power, capable of tackling problems our classical computers today cannot solve. Quantum computers have the potential to completely change how we use technology in the future, and the computational power is off the charts. This field has gained some serious momentum. Quantum computers could crack the world's most secure codes in minutes, design extraordinary new medicines, even pave the way to intelligent machines. Big tech companies like Google, IBM, and Microsoft are all trying to be the first to achieve a breakthrough in the field of quantum cloud. While we do not anticipate that quantum computers will be on a mobile phone because they require cryogenic cooling, we believe that access to quantum computers in the cloud will be something that people will be able to leverage behind the scenes even not knowing it is a quantum computer.*

***Keywords* -** *Quantum Computing, Quantum Storage, Quantum Battery, Quantum Mechanics, Graphene, Borophene.*

I. INTRODUCTION

Since the 1960s, the power of our brain machines has kept growing exponentially, allowing computers to get smaller and more powerful at the same time. But this process is about to meet its physical limits. Computer parts are approaching the size of an atom. Today, a typical scale for transistors is 10 nanometers, which is about 12 times less than the HIV virus' diameter. We are approaching a real physical barrier for our technological progress. In the quantum realm, physics works quite differently.

This research is intended to cover the birth of the quantum cloud, from designing quantum computer infrastructure to a machine capable of superseding all human's expectations of modelling and cracking codes. Who is investing in building it? Does the military have any interest in funding the development? The road to quantum cloud is not really open wide. It has some challenges that will be resolved to be available to everyone in hand or be in the cloud. All these concerns are covered.

With the quantum cloud comes a huge amount of data that need to be stored somewhere; however, the ordinary storage methods are not going to be enough. Glass seems to be the next storage evolution to close this gap which is going to be discussed as well.

Humanity's history is constantly developing, from the stone age, the bronze age, and the iron age. However, today it is under more complex circumstances, the space age, the nuclear age, and the information age. Moreover, we are entering the Graphene and the Borophene age, materials that will be so influential to our future they will define the period we live in. Graphene and Borophene technology include potential applications for use in medicine, electronics, light processing, sensor technology, environment, and energy.

II. QUANTUM COMPUTING

A. Quantum Mechanics

Tech giants like IBM and Google and startups like Rigetti Computing are all in something of a scientific race to build the first universal quantum computer. But to understand what makes a quantum computer so uniquely powerful, we will need to know a bit about quantum mechanics. Quantum mechanics is the field that describes the simplest things around us, individual electrons or atoms, or particles of light like photons. The fascinating thing is, when you look at these very simple systems, they do not really obey the same rules that the world around us does. We use sort of two very important properties of quantum mechanics, one of them is a superposition of states, and the other one is entanglement. Quantum mechanics is a field of physics that studies the behaviour of the most basic and smallest parts of our universe at the subatomic level. The quantum world is something that scientists are just now starting to try and understand.

Superposition is the phenomenon where particles can be in two states at the same time. Computers use bits that are either a 0 or a 1 to process information, but if we use quantum particles as data, something interesting happens. By using quantum particles called qubits and the property of superposition, they can read both as a 0 or a 1 at the same time. This makes the amount of data that can be represented exponentially greater. This allows quantum computers to press as far more data as classical computers will ever be able to do. If a quantum computer had one hundred qubits, it would be more powerful for some applications than all the supercomputers on earth combined. Three hundred qubits could hold more numbers simultaneously than there are atoms in the universe, so what could a billion qubits do (e.g. Fig. 1) [1].

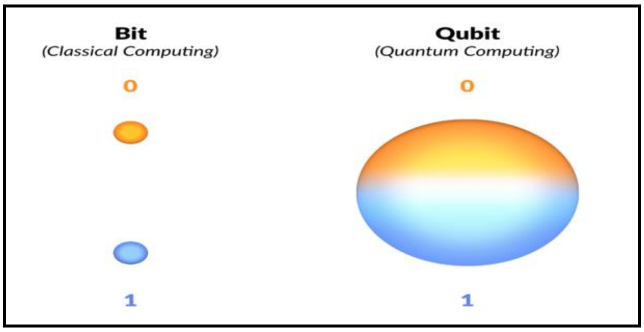

Fig. 1 Classical computers (bits) vs quantum computers (qubits)

Entanglement is another phenomenon where two particles can be linked so that one particle always gives the same outcome as the other. Entangled particles could mean that communication could be instant regardless of the distance between the particles. It could be great for security, too, since it potentially does not use any physical infrastructure to transfer this information. This means that in the future, it may be impossible for communication to be intercepted or hacked without the knowledge of the information's owner.

Modelling such a simple compound as calcium monofluoride makes our best supercomputers completely useless our current machines are so inaccurate because the electrons in the real world that are orbiting around these atoms are themselves in superposition. These electrons exist in multiple states at once, and we cannot model that properly with classical computers. Calculating all the possibilities is just too much (e.g. Fig. 2) [2].

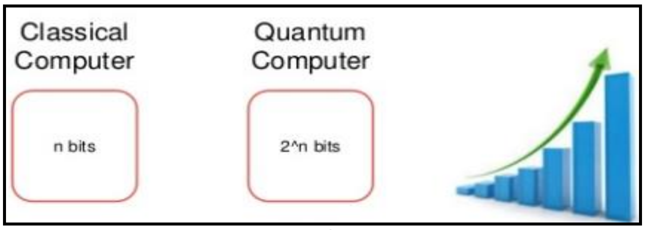

Fig. 2 Quantum computer bits far beyond classical computer

Quantum computers can keep up with the true complexity of nature, Richard Feynman. In quantum computers, entanglement along with superposition helps the system store all possible solutions at once (e.g. Fig. 3) [3].

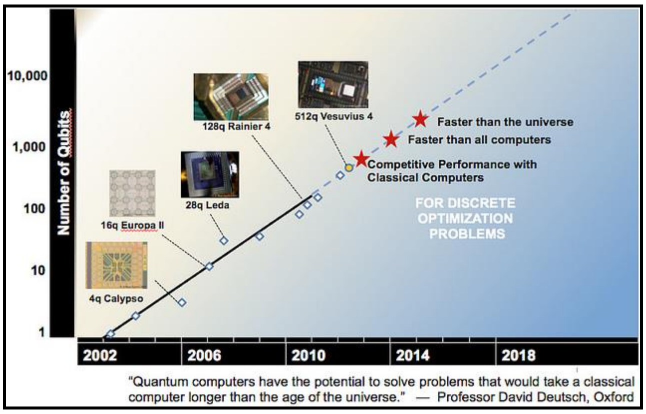

Fig. 3 Quantum computing progress regarding qubits (rose's law)

B. Infrastructure

To build a quantum computer, you need to start with a quantum chip and Rigetti, IBM, and other tech companies are investing in something called superconducting qubits. A superconducting qubit is just metal on a silicon chip. That metal is arranged in such a way that when you cool it down to a low enough temperature, the metal becomes superconducting. All the electrons can flow without electrical resistance, and they can take on individual quantum states. They are six inches in size. There is typically anywhere between a few dozen to a few hundred chips on this wafer. They get packaged into a circuit board that lets us make connections onto that chip. When we are making circuits on silicon, we must have the environment be free of dust and contaminants because we have very small features on these chips, and a piece of dust can screw them up."

In order to cool them down, you need an entire infrastructure of refrigeration, and for that, we rely on something called dilution refrigerators. We cool these chips down to around 10-15 millikelvin. The most noticeable sound you hear is the cryocoolers. They work by pulsing helium gas into and out of this refrigerator system in such a way that it's just continuously drawing heat out of the interior of the fridge. They need tightly controlled environments to operate in, changes in nearby temperatures and electromagnetic waves can cause them to mess up, and then there's the temperature of the quantum chips themselves. They need to be kept at temperatures colder than interstellar space, close to absolute zero (e.g. Fig. 4).

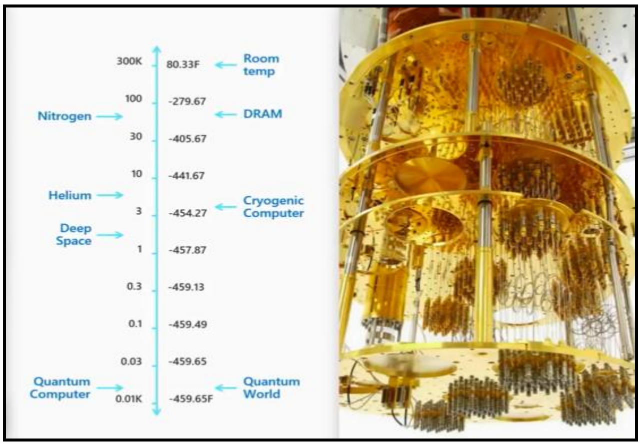

Fig 4. Quantum computing operations environment

Classical computers use logic gates to run functions. These take inputs and produce an output. Quantum gates, however, can do a lot more. The gates entangle change probabilities and collapse superposition qubits to produce results. Simply put, they can run all possibilities at once. Normally on a classical computer, it would check all the probabilities one by one. This all means that quantum computers can find a solution much faster, especially on large datasets.

Qubits can exist in both "0" and "1" states at once, allowing multiple computations to happen simultaneously. These states in a particle are called spin. While normal computer spits are made from tiny transistors, a qubit can be anything that exhibits quantum behaviour, an electron, an atom or even a molecule that is if the environment is right (e.g. Fig. 5).

Factor a number into primes: $M = p * q$

Classical	$t \sim \exp(O(n^{1/3} log^{2/3} n))$	28,000,000,000,000,000,000,000 years
Quantum	$t \sim O(n^3)$	100 Seconds

Fig. 5 Quantum computing super calculation capabilities

C. Security

A simple example of the powerful capabilities of quantum computing is when searching through a database that has got a list of about a million items, and we want to find one particular item through that list. An ordinary computer can do, is look through that list one item at a time, look at the first item, the second item, the third item until eventually, you find the item that we are looking for. However, a quantum computer can, in some sense, look at all those items simultaneously. Quantum computers will be able to help artificial intelligence learn better learn faster, optimize things, designing things if we are trying to design, for example, a shape of a car, so that air will flow over it in exactly the right way that's an optimization problem.

With respect to code-breaking, if we give an ordinary computer a code to break, it will try every possible combination one at a time but give a quantum computer a code to break, and it can try all the codes at once, this is a huge area of application of quantum computers, and it is really the financially the driving force in putting money into the industry and persuading people to really try to build it [4].

Quantum computing is amazing science, but like any new technology, it also introduces problems that we have not yet imagined or potentially intensify dangers we already face. In the last five years alone, hackers breached billions of accounts and systems worldwide. These attacks were all made with the classical computers we use today. Because of a quantum computer speed and power, there are no current security methods we employ that could fully protect our banks, identities, and even our infrastructure. At the University of Science and Technology of China, Dr Pangaean Way has created the first secure quantum communications network as a first step in countering the threat that actual quantum computers will pose.

That also means quantum computers is powerful and efficient enough could theoretically break RSA encryption. RSA is the type of encryption that underpins the entire internet. Governments and companies are beginning to get ready for it, for example, for health records, if health records are to be opened, that could compromise all kinds of things. Government communications, Banking records. Sometimes even banking records from decades ago contain important information that you don't want to expose. The danger is if you don't update your cryptography now, all the messages you send over the next few years and the ones in history could potentially be read (e.g. Fig. 6) [5].

Cryptographic algorithm	After quantum computing
AES-256	Secure but weakened
SHA-256	Secure but weakened
RSA	No longer secure
ECDSA	No longer secure
DSA	No longer secure

Fig. 6 Cryptographic algorithms between classical and quantum computer

D. Funding

Venture capital investors are pouring hundreds of millions of dollars into quantum computing startups, even though practical applications are years away. Just last year, private investors have backed at least 52 quantum technology companies around the world since 2012. Many of them were spun out of research teams at universities in 2017 and 2018. Companies received at least $450 million in private funding, which is more than four times the funding from the previous two years, that is nowhere near the amount of funding going into a field like artificial intelligence, about $9.3 billion with a venture capital money poured into AI firms in 2018, but the growth in quantum computing funding is happening quickly for an industry without a real application yet.

In IBM's research lab in Yorktown Heights, New York, the big tech company houses several quantum computers already hooked up to the cloud [6]. Corporate clients such as Goldman Sachs and JP Morgan are part of IBM's Q Network, where they can experiment with the quantum machines and their programming language. So far, it's a way for companies to get used to quantum computing rather than make money from it.

Perhaps the biggest business opportunity out of quantum computing in the short term is simply preparing for their widespread use of them. Companies and governments are already attempting to quantum-proof their most sensitive data and secrets.

E. Use Cases

Quantum computers can solve problems that would take infinitely long in a classical computer for things such as modelling the brain and modelling weather systems etc.

Quantum computers are good at things that have a small input and output while having a vast array of possibilities, for example, modelling complex molecules, the input is the number of particles in their starting state while the output is what happens after a given time, the possibilities of what happens in between that time are almost infinite. Another example breaking encryption in 1994, American mathematician Peter Shor of Bell Labs found a theoretical way to use quantum computers to break codes that relied on the factorization of large numbers into primes. This does not sound like much at first, but many online security systems, from banking to encryption, rely on the principle that it is currently almost impossible to take a very large number and figure out what the prime factors are.

The best algorithm known for classical computers uses a number of steps that keeps increasing exponentially until it takes billions of years, however using the algorithm by Peter shor called Shor's algorithm, a quantum computer could perform the task in just a number of hours, in this case, the input is a single large number, and the output is how many sets of prime numbers multiplied together to give that large number, again the possibilities here are almost infinite.

Other real-world problems of this type are from weather patterns and climate change to boosting artificial intelligence training from looking at patterns and stock market data or in recordings of brain activity, not to mention gene analysis and drug delivery as well as many other things. All in all, quantum computers are good at problems with limited inputs and almost infinite possibilities.

Database searching is an example of where quantum computing to be fully utilized. To find something in a database, a normal computer may have to test every single one of its entries. Quantum computers algorithms instead need only the square root of that time, which for large databases, is a huge difference.

Another exciting new use is simulations. Simulations of the quantum world are very intense on resources, and even for bigger structures, such as molecules, they often lack accuracy. So why not simulate quantum physics with actual quantum physics. Quantum simulations could provide new insights on proteins that might revolutionize medicine.

Quantum computers could simulate our universe, allowing us to model new molecules in an arrangement we haven't discovered and test them to find new materials. These new materials may help create other breakthroughs in science and engineering never thought possible, from new batteries and energy sources to super-strong materials and incredibly effective medicines. For example, to obtain the number of the possibilities for a molecule with 10 electrons, it will have 1000 states, and for a molecule with 20 electrons, it will be over 1 million possible states, modern laptop can model 26 electrons, a supercomputer 43 electrons but what about a 50 electrons system well, that's impossible for any classical computer in the future as far as humans will exist.

Nature and reality themselves are quantum systems, and they can't be modelled on a classical computer effectively. The information required to describe a quantum system can only be held by another quantum system. Consider the case of modelling different molecules. As you can see, when we get to molecules a bit more complex than benzene, the computational time to model them approaches infinity. For a quantum computer, all we have to do is just add more qubits and the computational time scales linearly with the problem. The quantum computers could predict climates accurately or model the human brain. The possibilities are endless.

F. Challenges

Maintaining the quantum environment, which is qubits to be in quantum superposition state that is being in multiple states at once, they need to be free from all radiation and kept at a temperature just above that of absolute zero. If the particle interacts with any slight disturbances such as light particles, radiation or even quantum vibrations, it can snap the particles out of their superposition state. Today, we can only achieve a quantum superposition for a tiny fraction of a second, not long enough to carry out a useful algorithm. Mastering this fragile quantum state remains one of the biggest challenges for engineers and scientists to build a practical quantum computer.

There are still some hurdles. The first problem is due to quantum physics itself. An observer can never directly know all the vast number of qubit states at the same time. All an observer knows the probability of what state the qubits will be in the very act of observing or measuring the overall state of the quantum computers qubits will force the system to decide on which state they are in, so instead of the quick trillions of answers we can only see one, and that's another quirk of the quantum world.

The code must be designed so that the qubits are likely to be in the correct state for a given problem hence giving us the right answer. Quantum code is designed to use the wave-like properties found in particle physics to cancel out the wrong answers and amplify the correct answer that can then be detected and viewed. The manipulation of nature through code is called a quantum algorithm mathematicians and scientists around the world are in a race to build these algorithms for when capable quantum computers arrive.

G. The Business Investment

Quantum computer designs consist of two main types for construction: the superconductor type and the spin type, which is the most popular method is a super cold metallic ring almost at absolute zero. At this temperature, electrons can flow around forever without ever bumping into anything. The best quantum computer we have uses the quantum dot method, so most of those qubits are used for error detection by Google and IBM.

Google was the primary interested party that pulled this whole thing together, and it is exciting because what they are going to do is apply this new computational idea in the service of trying to make intelligent machines, and this is fundamentally important. They are pushing the envelope to get ahead of the technology curve to be ready for what the future brings. It is amazing to use quantum physics to create a computer with the possibility of one million times more processing streams than all computers in the world today combined (e.g. Fig. 7) [7].

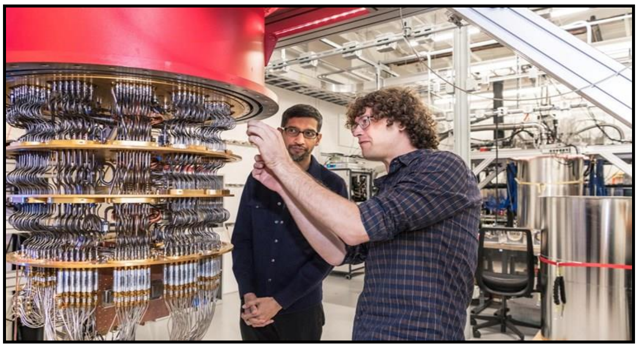

Fig. 7 Google quantum computer

In October 2019, Google made a big announcement. Google said it had achieved quantum supremacy. That's the moment when quantum computers can beat out the world's most powerful supercomputers for certain tasks. Google used a 53 qubit processor named Sycamore to complete the computation, a completely arbitrary mathematical problem with no real-world application. The Google Quantum computer spit out an answer in about 200 seconds. It would have taken the world's fastest computer around 10000 years to come up with a solution, according to Google scientists. With that, Google claimed it had won the race to quantum supremacy (e.g. Fig. 8) [8].

Fig. 8 Quantum supremacy (google 72-qubit computer)

Moreover, many other companies such as Honeywell, in addition to public cloud providers such as Microsoft Azure and Amazon AWS, are joining the quantum race from startups all the way to established names. IBM also wants a commercial quantum computer in as little as 3 to 5 years. Quantum computers hold great promise, but it is still going to be multiple decades before we have a meaningful machine (e.g. Fig. 9).

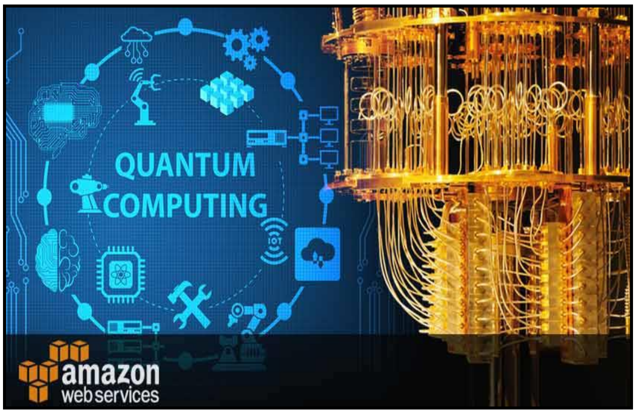

Fig. 9 Amazon aws quantum computer

These quantum computer machines are currently deployed in openly available research centres. Like the supercomputers were introduced to the world, quantum computers also are too big, too expensive, and difficult to operate at anyone's home. Instead, they need a place where they are managed professionally and efficiently and be available as a shared resource that could be offered as a service to the world, and what a better place than the public cloud. Amazon, Google, IBM and Microsoft, plus a host of smaller companies such as Rigetti and D-Wave, are all betting big on Quantum (e.g. Fig. 10) [9].

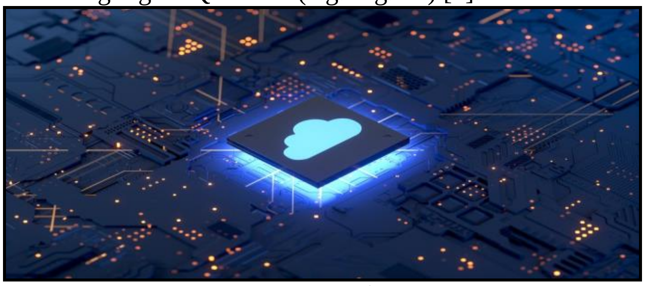

Fig. 10 Quantum computing future public cloud

The first computing device to tap into quantum principles called the D-Wave is now being used by the United States biggest defence contractor Lockheed Martin. Problems that we cannot solve with the amount of time and resources. Advanced weapon systems are using increasingly more complex software like the F-35, which runs on more than eight million lines of code. The software verification problem is something that is particularly difficult. It is something that consumes a huge amount of resources for Lockheed Martin.

Quantum computers use the natural world to produce machines with staggeringly powerful processing potential. IBM believes quantum computing is going to be the most important computing technology of this century. We could use quantum computers to simulate molecules, build new drugs and new materials and solve problems plaguing physicists for decades. The financial world, economists, stock markets such as Wall Street in the United States could use them to optimize portfolios, simulate economic forecasts and for complex risk analysis. Quantum computing could also help scientists speed up discoveries in fields like machine learning and artificial intelligence (e.g. Fig. 11) [10].

Fig. 11 Quantum computing investors

III. QUANTUM STORAGE

The Glass seems to be the material of the future, and the new smart homes exploiting it is featured, from photovoltaic Glass to replace your home windows from an ordinary transparent glass to adaptable changing colour mode depending on the sunlight to grey or brown, the bathroom and living room mirror will replace the Ultra-LCD television or computer monitor we have now, kitchen solid granite countertop also to be an interactive surface, the refrigerator door with all printed family pictures on to a smart appliance veneer glass interact with gadgets such as tablets, mobile phone with full interoperability and mobility, even the autonomous vehicles with personal customization with adaptable street road signs.

A. Nanograting

If everything were to remain as it is with our faulty hard drives and flimsy CDs, all the information we have today would degrade, and soon, glass technology has gone further than just interactive media display. The technology of reading information based on the bending of light inside Glass, the ability to conceive of an extra dimension of digital information is invented and tested by the University of Southampton, UK. Nanograting technology is the key, placing nanoscale dots so precisely that they can sit in different orientations, making the light refract off them in different directions entirely and at different intensities. It has become humanity's new way to store information in almost just as little space. With a special disk reader that is on its way to becoming a commercially viable product, these devices use a powerful microscope and a polarizer to read the data of bombs stacked up at different degrees letting light through or not (e.g. Fig. 12) [11].

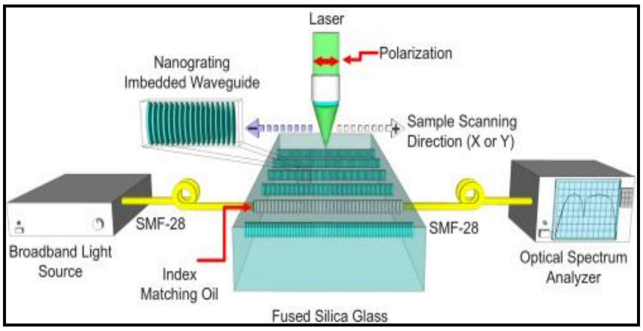

Fig. 12 Nanograting

In 2013 they successfully created a glass disk that reads data in five dimensions of space. A glass disk that stores information so densely that it retains 3000 times the information of a normal CD should last 13.8 Billion years and sustain the blistering heat of a thousand degrees Celsius. The Blu-ray disc stores 128 GB of data, a glass disk of the same size stores 360 TB. The tech is pretty much perfected at this point. The researchers at the University of Southampton put copies of the Bible, Isaac Newton's optics and the UN Declaration of Human Rights on discs already (e.g. Fig. 13).

Fig. 13 Glass future disc vs blu-ray disc capacity

B. Hitachi Fused Silica

Today's recording media offer incredibly advanced storage density, but how can we preserve our history, cultural heritage, official documents, and other vital data for posterity? Recording life must be extended to achieve success. Combining long life with high density is an urgent issue for our times.

Since 2008, Hitachi has been hard at work doing research on super long-term data storage technology. Hitachi is closely examining fused silica as a new recording medium. The superbly heat resistant and durable material is used in applications from beakers to optical fibres. Hitachi has proven that data recorded on fused silica does not deteriorate even when heated to 1000 degrees Celsius for two hours. This means that data recorded on fused silica has the potential to last for over 300 million years. The data is recorded inside highly durable fused silica using femtosecond pulses which is a high output laser. An industry-academia and partnership with Kyoto University are responsible for achieving this breakthrough. The interior of the fused silica is exposed to laser light to carve a 2-dimensional code consisting of a dense field of dots. Hitachi is conducting recording and playback tests for carving data on multiple layers for high-density and was able to record on 100 layers (e.g. Fig. 14).

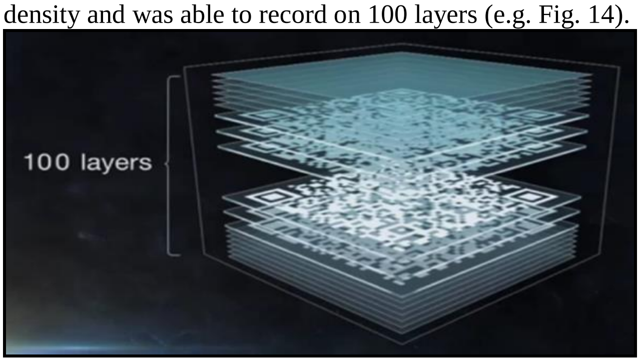

Fig. 14 Silica storage multiple layers

In 2014 the ultra-compact artificial satellite Shin-en 2 was launched with a payload that included a pane of a few silica inscribed with messages to a future 300 million years away. Those messages continue to fly through space today. The British Museum is presenting a Hitachi fused silica recording technology, and it was selected as one of the items used to pass that information on and preserve humanity's heritage to future generations (e.g. Fig. 15).

Fig. 15 British museum hitachi silica recording

C. Microsoft Project Silica

A breakthrough proof of concept from Microsoft "Project Silica" aims to show that Glass is the future of long-term data storage by using the Femto Laser and Nanograting technology. To put the technology into perspective, at Warner Brothers studios, CA, USA, inside a temperature-controlled vault that is a top-secret, they have 750 thousand film elements, the first Warner Brothers property to get Microsoft's Project Silica treatment was 1978 original "Superman" movie, condensing 22 reels of films into one piece of Glass that can fit in anyone's pocket. The media can cope with water which means data can be stored in a data centre without worrying about fire or any type of extinguishers. The media cope with heat which reflects on how we cool our data centres, and sure it can sustain electromagnetic pulses, or the physical surface is not important to protect it as we do with CDs and DVDs, scrapping will not affect any stored information, the only way to get rid of the sorted information is to melt the Glass or grind it (e.g. Fig. 16) [12].

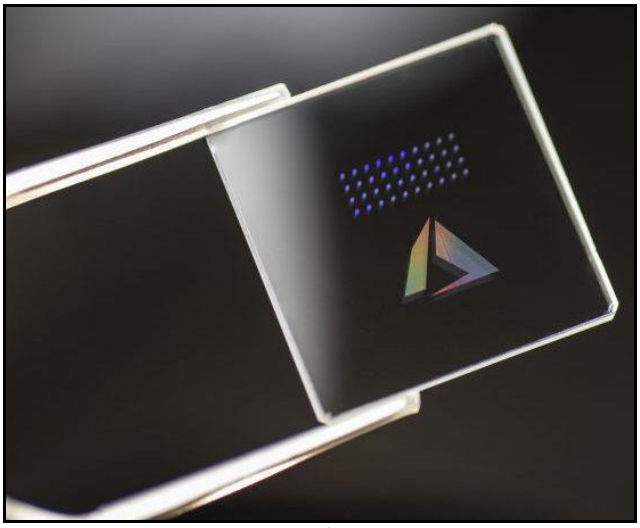

Fig. 16 Microsoft project silica

IV. QUANTUM BATTERY

A. Samsung Battery Technology

Imagine a world where mobile devices and electric vehicles charge five times faster than they do today, cell phones, laptops and tablets that fully charge in only 12 minutes or electric cars that fully charge at home in only an hour. Samsung had made this possible through the development of a battery made of Graphene with charging speeds five times faster than standard lithium-ion batteries.

Graphene is made of graphite which is the crystallized form of carbon and is commonly found in pencils. Graphene is a single atom thick structure of carbon atoms arranged in a hexagonal lattice, and like a million times thinner than a human hair, it is 200 times stronger than steel and as much as six times lighter, it can stretch up to a quarter of its length, and at the same time it's the hardest material known, it is even harder than a diamond.

Graphene can conduct electricity faster than any known substance, 140 times faster than silicon. It can also conduct heat 10 times better than copper. Graphene is a transparent material. 7% of light passes through Graphene. It is also the most impermeable material known. Even helium atoms can't pass through Graphene (e.g. Fig. 17).

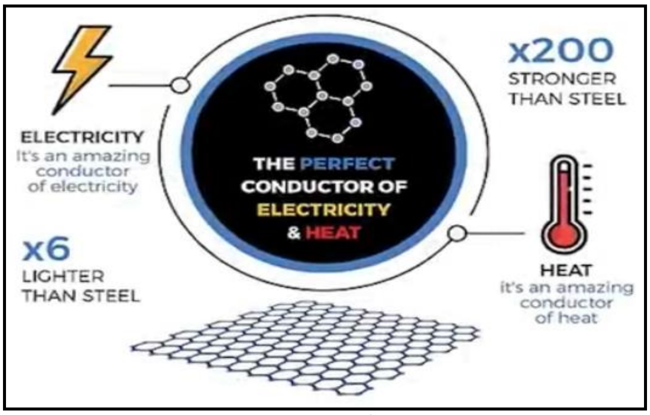

Fig. 17 Graphene features

In 2004, the University of Manchester, scientists Andre Geim and Konstantin Nava Slav successfully isolated one atom thick flakes of Graphene for the first time by repeatedly separating fragments from chunks of graphite using tape, and they were awarded the Nobel Prize in Physics in 2010 for this discovery. With the easier accessibility of Graphene, there are more and more scientists researching this amazing material for potential applications which can be game-changing for so many aspects of our everyday lives.

Samsung researchers discovered a mechanism to synthesize Graphene into a 3D form like popcorn using silicon dioxide. They call this 3D form a Graphene ball which they use to coat the electrodes of the battery. According to Samsung, using the Graphene ball material on batteries increase their capacity by 45% and, in turn, increase their charging speed by five times while the current lithium-ion batteries take an hour to fully charge, but this will be reduced to 12 minutes. Samsung not only aims to improve batteries for mobile devices they also want to improve electric vehicle batteries as well (e.g. Fig. 18).

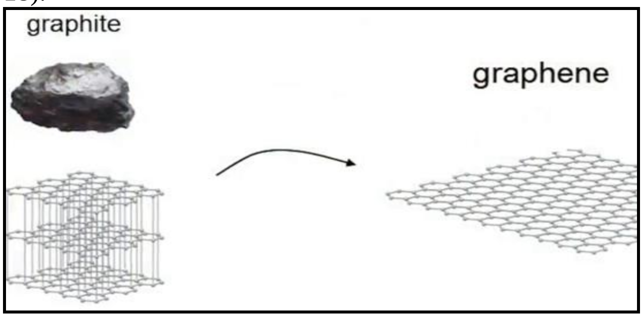

Fig. 18 Graphite vs Graphene

Graphene batteries have a longer lifetime. Most phone batteries can last around 600 charge cycles. The new batteries are rated for 1,500 cycles for the same capacity. It is also safer than regular batteries as well because the cell generates much less heat and runs much cooler [13].

Graphene was massively expensive a few years ago, one kilo of Graphene would have cost $300,000, but thanks to advancements in the manufacturing process, this cost is falling dramatically, in 2010 it used to be around $1,000 per cubic centimetre and now is only 1 cent, and this is the key to why Graphene is finally coming online. Graphene battery would add about 30% extra cost to the battery component of a phone, but with the benefits, consumers would not mind (e.g. Fig. 19) [14].

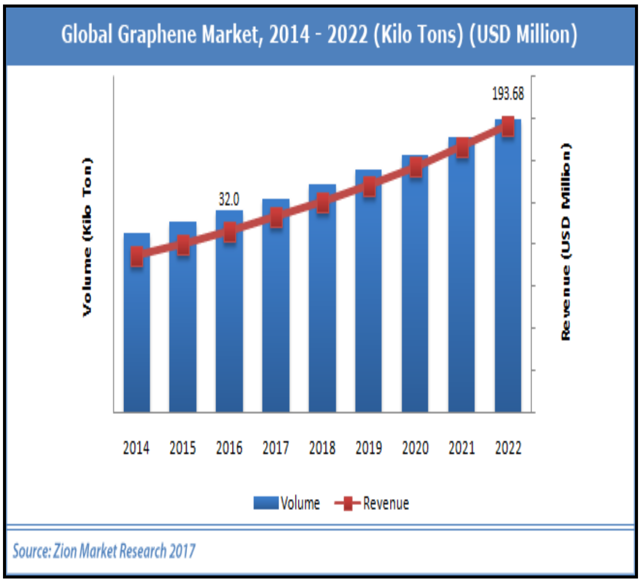

Fig. 19 Global graphene market revenues

The European Union invested €1 billion to kick-start a Graphene industry, it has triggered an interest in other two-dimensional materials, and the most exciting of all is Borophene; a single layer of boron atoms that form various crystalline structures. The reason for the excitement is theextraordinary range of applications that Borophene looks good for. Electrochemists think Borophene could become the anode material in a new generation of more powerful lithium-ion batteries [15].

B. IBM Natural Battery

IBM Research recently announced that it had invented a battery that can be made from minerals found in ocean water that are all safe and easily obtainable and ultimately outperforms lithium-ion battery technology. It is worth mentioning that it does not use any heavy metals such as nickel or cobalt that are hard to source and can pollute the environment. IBM says this battery chemistry has never been documented before and claims that it will be cheaper to make because the cathode materials will cost less and are more abundantly found in nature.

IBM claims that this battery can be charged to 80% state of charge in less than five minutes, and the battery exceeds the maximum power and energy density of any currently available lithium-ion battery. This shows a lot of promise because the others rely on rare earth metals or are expensive to mine materials and meaningful quantities, no single country or region of the globe will control access to the materials. It is readily available to almost everyone (e.g. Fig. 20).

Fig. 20 IBM Natural battery

V. CONCLUSION

Quantum cloud can analyze large quantities of data patterns quickly. They could tackle optimization problems for transportation and industry, advance climate modelling, and boost artificial intelligence research one day. Glass storage development is very promising to accommodate the quantum computer demand. Hitachi and Microsoft are the main investors, and more to come.

The future is wide open when Graphene and Borophene technology is fully matured. It will make a significant difference not only for mobile phones and laptops, but most excitingly, electric cars and electric planes, and the grid energy storage, it could change material science and engineering forever.

The computing world as we know is getting a lift, a new ride to the future, an upgrade called Quantum Computing. Quantum computer is in their infancy. Just like the classical computer was in the 1950s, research is going ahead and not slowing down. Quantum cloud holds the potential for a radical change in the progress of humanity.

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