DECOMPOSITION OF EARTH DEBRIS

Abstract-*All man-made objects in Earth's orbit that are no longer usable are referred to as space trash. From small particles to enormous, abandoned spaceships, space debris can come in a variety of sizes. A rising issue, space debris puts functioning spacecraft at risk and can add to the problem by colliding with other objects in orbit.Decomposing space junk into smaller fragments, which will eventually deorbit and burn up in the Earth's atmosphere, is the process of removing space debris from its original state.For space exploration and use to be sustained over the long term, decomposition solutions for space trash must be developed and put into use.For space exploration and use to be sustained over the long term, decomposition solutions for space trash must be developed and put into use.In this study, we investigate methods for breaking down the heavy metals, such as nickel, titanium, gold, and aluminum, that are utilized in spaceship construction in order to reduce space trash.additionally, we discover several metals that can substitute these metals, such aerogels, nanostructured particles, biodegradable materials, and self-destructing materials.*

1. Introduction

Any human-made item in orbit around the Earth that is no longer usable is referred to as space garbage or space rubbish. It might be as small as a particle or as big as a giant crashed spacecraft. As it puts functioning spacecraft at danger and can produce more debris when it collides with other objects in orbit, space debris is a rising hazard.There are several risks that operating spacecraft may face from space junk. It has the potential to crash with spacecraft, damaging or possibly destroying them. Additionally, space debris can obstruct satellite communications and navigation.Space debris is an issue for the environment in addition to the risks it presents to spacecraft that are currently in operation.

Fig:-1.1

Space junk can burn up upon re-entering the Earth's atmosphere, but it can also fall to the ground and provide a risk to people and property.There is no simple answer to the complex issue of space junk. But because it poses a serious threat to the continued exploration and use of space, it is crucial to solve the issue.

1.1. why space debris is formed

Failures during launch: If a launch vehicle fails, some or all of it may stay in orbit and produce space debris.

Collisions: When space debris comes into contact with other orbiting objects, more debris is produced.

Satellite disintegration: Satellites can disintegrate for a variety of reasons, such as aging, collisions, and explosions. A significant debris cloud may result from this.

Anti-satellite tests: A few nations have carried out anti-satellite tests in which spacecraft were purposefully destroyed while in orbit. Space debris has been significantly increased as a result of this.

Impacts caused by micrometeoroids: Micrometeoroids are tiny space debris that move quickly through the atmosphere. They may leave behind minor debris when they strike satellites and other objects in orbit.

1.2. The most used element to construct spaceship which causes debris Aluminum

Due to its strength, low weight, and durability, aluminum is a popular metal in the building of spacecraft. Additionally, it is manageable and reasonably inexpensive.

Here are some examples of how aluminum is used specifically in spaceship construction:

Aluminum is used to build the fuselage, wings, and tail of many spacecraft, as well as their airframes. Because they are sturdy and lightweight, aluminum airframes are perfect for spacecraft.

Fuel tanks: Aluminum is also used to build spacecraft fuel tanks. Fuel tanks made of aluminum are strong, lightweight, and able to handle the high temperatures and pressures of rocket fuel. **Thermal insulation:** Aluminum can be used to insulate spacecraft's interiors from heat. The high temperatures in space can be mitigated with aluminum thermal insulation.

Other parts: A wide range of other parts for spacecraft, including engines, landing gear, and electrical cables, are made of aluminum.

Fig:-1.2.1

The advantages of employing aluminum in spaceship construction include the following:

One of the lightest metals on the market is aluminum. Because every ounce counts in spaceflight, this makes it the perfect choice.

powerful: Despite being lightweight, aluminum is a powerful metal. Due to its ability to withstand the stresses of launch and re-entry, it is perfect for spacecraft.

Long-lasting: Aluminum is a long-lasting metal that can resist the severe conditions of space.

Cost: Aluminum is a relatively inexpensive metal, making the use of it in the construction of spacecraft economical.

Aluminum is a metal that is reasonably simple to work with. This enables the production of intricate spaceship components from aluminum.

Nickel

A versatile metal, nickel is employed in the manufacture of spaceships among other things. It is highly valued for its durability, heat tolerance, and corrosion resistance.Because of their excellent strength and heat resistance, nickel alloys are employed in the manufacturing of rocket engines. Nickel alloys are resistant to the high pressures and temperatures seen during rocket combustion.

Fuel tanks: The fuel tanks for spaceships are likewise made of nickel alloys. Fuel tanks made of nickel alloy are sturdy,

lightweight, and resistant to the high pressures and temperatures associated with rocket fuel.Due of their excellent strength and heat resistance, nickel alloys are employed in the building of spaceship turbines. Turbines made of nickel alloy can survive the high heat and pressures that come with space travel.

Other parts: Nickel alloys are also used to make a wide range of additional spacecraft parts, including landing gear, electrical cables, and propulsion systems.

Fig:-1.2.1

Strength: Even at high temperatures, nickel alloys are exceptionally durable. Since they can endure the stresses of launch and re-entry as well as the incredibly high temperatures of space, they are the perfect material for spaceship components.

Resistance to corrosion: Nickel alloys have a high level of corrosion resistance. They are therefore perfect for spacecraft components that will be subjected to radiation, vacuum, and other hostile conditions in space.

Heat tolerance: Nickel alloys are heat-resistant and have a high melting point. They are therefore perfect for spaceship parts like rocket engines and turbines that will be exposed to high temperatures.

Lightweight: The relative lightness of nickel alloys is significant for spacecraft, where every ounce counts.

Gold

Due to its weight and cost, gold is normally not utilized in the construction of spacecraft. Gold is utilized in a number specific ways in spacecraft, including:

Thermal regulation: Since gold reflects infrared light well, it can be utilized to insulate spacecraft from heat. For instance, the Hubble Space Telescope and other spacecraft are protected from the sun's heat using gold foil.

Good conducter:-Gold is frequently used in electrical connectors in spacecraft because it is a good conductor of electricity and corrosion-resistant. For instance, the electrical connectors for the International Space Station are made of gold.

Fig:-4

Cost: Gold is a material that is fairly pricey. Because of this, using gold for substantial spaceship components is prohibitively expensive.

Weight: A comparatively heavy metal is gold. It is crucial to utilize gold sparingly in spacecraft since every ounce counts there.

Gold is a delicate metal and should be protected from harm because it is a soft metal.

Gold is a valuable metal for several spacecraft purposes despite these difficulties. It is perfect for use in temperature control, electrical contacts, and visors thanks to its special thermal conductivity, corrosion resistance, and ultraviolet reflectivity qualities.

Titanium

Titanium is a popular material for spaceship building because it is strong, lightweight, and long-lasting. It is also resistant to high temperatures and corrosion, which makes it perfect for the harsh conditions of space.

Titanium is used to build the fuselage, wings, and tail of many spacecraft, as well as other aircraft components. Titanium airframes are strong and lightweight, making them perfect for use in spacecraft.

Titanium is also used to build the spacecraft engines. Titanium engines are strong, lightweight, and resistant to the extreme heat and pressures involved in rocket combustion.

Titanium is also employed in the construction of spaceship fuel tanks. Fuel tanks made of titanium are sturdy, lightweight, and able to handle the high heat and pressures of rocket fuel.

Other parts: A wide range of other parts for spacecraft, including landing gear, electrical wiring, and heat exchangers, are made of titanium.

Fig:- 5

One of the lightest metals on the market is titanium. Because every ounce counts in spaceflight, this makes it the perfect choice.

Strong: Even when it is lightweight, titanium is a strong metal. Due to its ability to withstand the stresses of launch and re-entry, it is perfect for spacecraft.

Titanium is a strong metal that is capable of withstanding the severe conditions of space.

Titanium has an extremely strong corrosion resistance. As a result, it is perfect for spaceship components that will be subjected to radiation, vacuum, and other hostile conditions in space.

Heat resistance: Titanium is heat resistant and has a high melting point. This makes it perfect for spaceship parts, such rocket motors, that will be exposed to extreme temperatures.

2. methodologies to decompose metals

It is very difficult to decompose aluminum in space due to it's characteristics

2.1. laser ablation

Laser ablation is a promising method for decomposing aluminum in space. It is a fast and efficient process that can be used to decompose aluminum into its constituent elements. Laser ablation is also a relatively precise process, which means that it can be used to selectively decompose aluminum without damaging other materials.One way to use laser ablation to decompose aluminum in space is to use a laser to heat the aluminum to a high temperature, causing it to vaporize. The vaporized aluminum can then be collected and recycled.Another way to use laser ablation to decompose aluminum in space is to use a laser to create a plasma. A plasma is a state of matter in which the atoms have been stripped of their electrons. Plasma is very hot and can be used to decompose aluminum into its constituent elements.

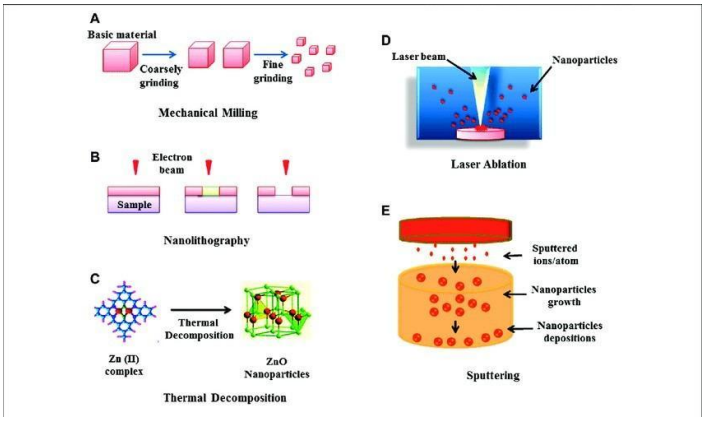

Fig:-5

tilizing a laser to generate plasma is another approach to use laser ablation to break down metal in space. A condition of matter called a plasma is one in which the electrons have been removed from the atoms. Aluminum may be broken down into its component elements using plasma, which is extremely hot.For the quick, effective, and exact decomposition of aluminum in space, laser ablation is a potential technique. Before laser ablation is extensively employed for this purpose, there are a few issues that must be solved.The fact that laser ablation uses a lot of energy presents one difficulty. In space, where there are less energy resources, this can be difficult. A further difficulty is that laser ablation can produce dangerous byproducts like ozone. To keep the environment in space from becoming contaminated, these leftovers need to be handled carefully.Laser ablation is a promising technique for breaking down aluminum in space, notwithstanding these difficulties. It is expected that laser ablation will become more effective and inexpensive as research in this field develops. As a result, laser ablation might be a practical method for destroying metal in space and lowering the amount of space junk.

2.2. plasma torch

Plasma torches generate high-velocity plasma streams, stripping atoms of their electrons. These streams can be used to mitigate space debris by melting and vaporizing objects, breaking them into smaller fragments for reentry incineration.Plasma torches offer a versatile and straightforward solution for space debris mitigation. Capable of effectively destroying a wide array of debris objects, including large satellites and rocket stages, they simplify operations while enabling controlled deorbiting, ensuring the safe incineration of debris upon reentry into Earth's atmosphere. Challenges associated with the use of plasma torches for space debris destruction include their high power requirements, the potential emission of harmful radiation, and limited effectiveness against certain debris types, particularly small objects composed of dense materials.

The process of eliminating space debris with a plasma torch involves several steps. First, the space debris is identified using ground-based instruments and satellites. Then, its position and trajectory are tracked for precise targeting. For large debris, mechanical tools or robotic arms can be used to approach and weaken the structure, while smaller debris can be directly subjected to the plasma torch. The torch is deployed from a satellite or spacecraft and positioned strategically to heat and vaporize the debris, breaking it into smaller fragments that will naturally deorbit and burn up in Earth's atmosphere. Monitoring the results is essential to ensure successful elimination, accomplished through telescopes and orbital satellites.

A key benefit of using plasma torches to break space debris into smaller fragments is that these smaller pieces are more likely to re-enter Earth's atmosphere and burn up, significantly reducing the risk of collisions with operational satellites.

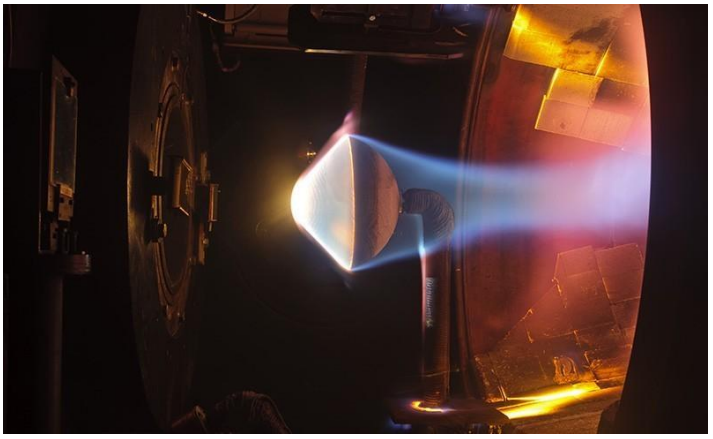

Fig:- 2.2.1

2.3 microwave plasma

A proposed solution for more efficiently breaking down space junk is microwave plasma. Despite being a relatively new technique, it provides a lot of benefits over existing strategies for clearing space trash.A gas is heated using microwaves to produce microwave plasma. The gas molecules vibrate as a result of the microwaves, producing heat. A plasma is produced when the gas molecules ionize as a result of the heat.The loss of electrons causes the atoms to become in the state of matter known as plasma. Up to tens of thousands of degrees Celsius, plasma is extremely hot. Debris from orbit can be broken down using this high temperature.Compared to previous techniques, microwave plasma has a number of advantages in the cleanup of space debris. It decomposes a wide range of materials quickly and efficiently. Utilizing microwave plasma is also generally risk- free and produces no toxic consequences.The enormous energy needs for microwave plasma to disintegrate space junk are one of the difficulties. Operating microwave plasma needs a significant amount of electricity, which presents a problem in space because there aren't many energy supplies there.Creating targeting and tracking devices that can precisely target and vaporize specific particles of debris is another issue.

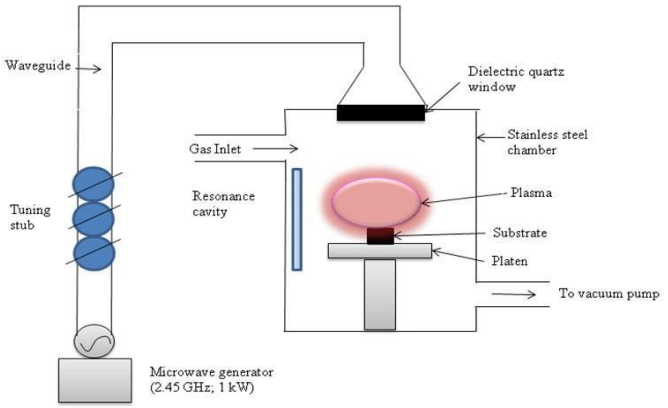

Fig:- 2.3.1

Despite these difficulties, microwave plasma is a promising technology for more economically decomposing space junk. The efficiency and cost of microwave plasma are projected to increase as research in this field progresses. Due to this, microwave plasma may be a practical solution for lowering space debris levels and enhancing everyone's safety in space.

3. Alternatives for metal in construction of space craft

3.1. Aerogels

A type of extremely lightweight materials having a porous structure are called aerogels. They are created by draining a gel's liquid, which leaves behind a solid with a density that is typically less than 1% of the gel's original density. Aerogels are also incredibly resilient and have superior thermal insulating qualities**.** There are several ways to use aerogels in spacecraft construction to reduce space debris.

- Aerogels can be utilized to make strong and lightweight spaceship parts. This may contribute to a decrease in the overall mass of the spacecraft, which may result in a decrease in the fuel needed to launch and maneuver the spacecraft. When a spacecraft is launched and deorbited, less fuel mass might also result in less space debris being produced.
- For spacecraft, aerogels can be utilized to generate thermal insulation. This can assist shield the spacecraft from the harsh temperatures of space, extending the life of the object and lowering the need for maintenance. Reducing the need for maintenance can also result in less space trash being produced.
- For spacecraft impact protection, aerogels can be employed. Due to their excellent energy absorption capabilities, aerogels can aid in shielding spacecraft from harm brought on by impacts with space junk. The lifespan of the spacecraft can be increased and the requirement for replacement parts can be decreased by lowering the risk of damage from space junk.

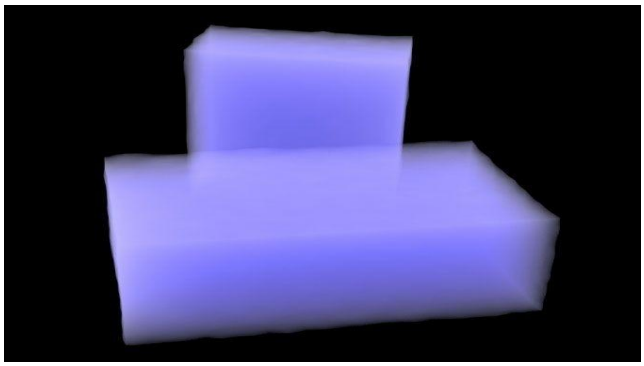

Fig:- 3.1.1

In addition to these advantages, aerogels may be produced from a wide range of materials and are generally simple to make. They are therefore an affordable means of lowering space junk. Aerogels are a substance that has a lot of potential for lowering space trash. They are strong, resilient, lightweight, and have exceptional impact and thermal insulation qualities. Aerogels are an affordable alternative for lowering space trash since they are reasonably simple to create and can be made from a range of materials. Aerogels are projected to become more crucial as this field of study develops in the construction of spacecraft and the eradication of space trash.

3.2. Biodegradable polymers

A promising class of materials for minimizing space debris is biodegradable polymers. They can be decomposed by microbes into harmless byproducts and are created from renewable materials. They are therefore perfect for use in parts of spacecraft that will eventually de-orbit and re-enter the atmosphere of the Earth.

- Airframes: The fuselage, wings, and tail of a spacecraft's airframe can be built from biodegradable polymers. Airframes made of biodegradable polymer can be made to safely deorbit and re-enter the Earth's atmosphere. They are sturdy and lightweight.
- Fuel tanks: Spacecraft fuel tanks can be built using biodegradable polymers. Lightweight and tough, biodegradable polymer fuel tanks can be made to safely deorbit and re-enter the Earth's atmosphere.
- Other parts: A wide range of additional spacecraft parts, including landing gear, electrical wiring, and thermal insulation, can be built using biodegradable polymers.

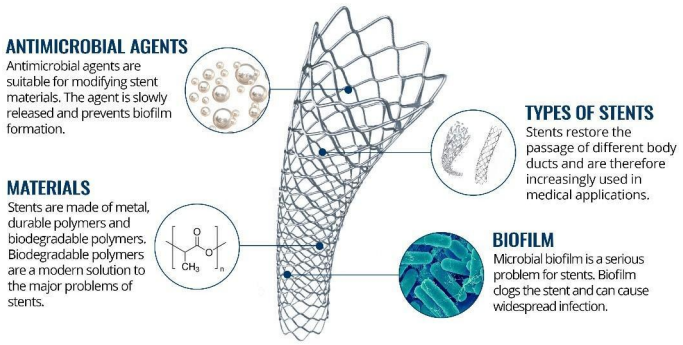

Fig:- 3.2.1