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Mechanical Aspects in Stealth Technology: Review

Bipin Kumar Jha, Mayur Somnath Aswale

Abstract— **Stealth refers to the act of trying to hide or evade detection. Stealth technology is ever increasingly becoming a paramount tool in battle especially "high technology wars" if one may occur in the future where invincibility means invincibility. Able to strike with impunity, stealth aircraft, missiles and warships are virtually invisible to most types of military sensors. The experience gained at the warfront emphasizes the need to incorporate stealth features at the design stage itself. The other purpose is to share the recent achievements related to the *advanced composite materials* used on various aero structures across the globe. Also discussed are the possibilities of achieving stealth capability on our existing fleet of fighter and bomber aircrafts of our Indian Armed forces using *composite and smart materials*. *Stealth technology also known as LOT (Low Observability Technology) is a technology which covers a range of techniques used with aircraft, ships and missiles, in order to make them less visible (ideally invisible) to radar, infrared and other detection methods.***

Stealth Technology essentially deals with designs and materials engineered for the military purpose of avoiding detection by radar or any other electronic system. Stealth aircraft are aircraft that use stealth technology to make it harder to be detected by radar and other means than conventional aircraft by employing a combination of features to reduce visibility in the visual, audio, infrared and radio frequency (RF) spectrum. Well known examples include the United States' *F-117 Nighthawk (1980s-2008), the B-2 Spirit "Stealth Bomber," and the F-22 Raptor.*

Index Terms— **Low observability Technology, Radar Absorbent Material, Composites and Smart Material.**

I. INTRODUCTION

Stealth technology also known as LOT (Low Observability Technology) is a technology which covers a range of techniques used with aircraft, ships and missiles, in order to make them less visible or partially invisible (ideally invisible) to radar, infrared and other detection methods. The stealth technology is used first time in the last year of World War II. The term "stealth", is thought to have been coined in ***1966 by Charles E. "Chuck" Myers***, combat pilot and later an exec at Lockheed. When we think of stealth today, immediately images of the *B-2* bomber or the *F-117A Nighthawk fighter* come to mind.

In simple terms, stealth technology allows an aircraft to be partially invisible to Radar or any other means of detection. This doesn't allow the aircraft to be fully invisible on radar. All it can do is to reduce the detection range or an aircraft. This is similar to the camouflage tactics used by soldiers in jungle warfare. Unless the soldier comes near you, you can't see him. Though this gives a clear and safe striking distance for the aircraft, there is still a threat from radar systems, which can detect stealth aircraft. Stealth technology is expanded into each of those areas which seek to detect the aircraft, ships & missiles.

Bipin Kumar Jha, is Student of Department of Mechanical Engineering, Guru Gobind Singh College of Engineering & Research Centre, Nashik: 422009, INDIA, Mobile No. +91-9028939604

Mayur Somnath Aswale, is Student of Department of Mechanical Engineering, Guru Gobind Singh College of Engineering & Research Centre, Nashik: 422009, INDIA, Mobile No. +91-9637960366

II. HISTORY

In the late 1930's and 1940's Radar technology was commonly used for detecting aircrafts. The Germans developed a radar absorbing paint. While this ferrite-based paint was much too heavy for aircraft, it could be used on submarines. Old bombers were converted to spy planes, but they soon proved to be very vulnerable to attack. In order to plug this intelligence gap, a new plane was designed. The idea was to create a plane that could cruise safely at very high altitudes, well out of the reach of any existing fighter. The design specification required that "consideration is given to minimize the delectability by enemy radar." The task of making this plane a reality fell upon the Advanced Development Projects team at Lockheed in California. The aircraft they developed became known as the U-2, and it was highly successful. After much effort they were successful in building an aircraft that could evade the enemy RADAR's called the ***F-117A*** *nicknamed as the "****Nighthawk****",* developed by Lockheed Martin in 1983.

Figure 1: The F-117A Nighthawk Stealth Fighter, a single seat, twin engine aircraft developed by Lockheed Martin.

III. RADAR

RADAR is the acronym for Radio Detection and Ranging. Radar is an object-detection system that uses radio waves to determine the range, altitude, direction, or speed of objects. Radar is something that is in use all around us, although it (radio waves) is normally invisible. RADAR basically works on two major principles.

A. ECHO

As the name suggest it is related to the sound waves it occurs because some of the sound waves in your shout reflect off of a surface (either the water at the bottom of the well or the canyon wall on the far side) and travel back to your ears. A mirror is an example of light waves being reflected back at one's self. Light from an external source hits a body and bounces off in several directions. Some light waves propagate towards the mirror and then reflect off of the mirror back to that person's eyes. This same exact principle applies to radio waves. Radio waves are simply non-visible forms of light. The idea behind radar is to transmit a radio wave and then receive the reflection from an aircraft. The amount of time between the transmission and the reception can be used with a very accurate number for the speed of light to determine how far away the plane is from the radar station.

B. Doppler Shift

Doppler shift occurs when sound is generated by, or reflected off of, a moving object. Doppler shift in the extreme creates **sonic booms.**

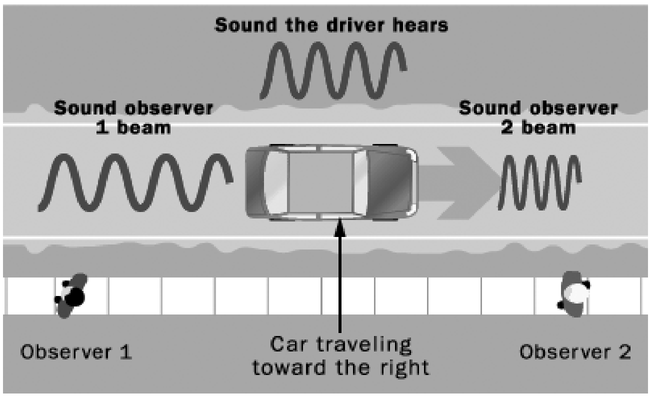

Figure 2: Audio Example of Doppler shift

Imagine that the car is standing still, it is exactly 1 mile away from you and it toots its horn for exactly one minute. The sound waves from the horn will propagate from the car toward you at a rate of 600 mph. What you will hear is a six-second delay (while the sound travels 1 mile at 600 mph) followed by exactly one minute's worth of sound. Now let's say that the car is moving toward you at 60 mph. It starts from a mile away and toots its horn for exactly one minute. You will still hear the six-second delay. However, the sound will only play for 54 seconds. That's because the car will be right next to you after one minute, and the sound at the end of the minute gets to you instantaneously. The car (from the driver's perspective) is still blaring its horn for one minute. Because the car is moving, however, the minute's worth of sound gets packed into 54 seconds from your perspective. The same number of sound waves are packed into a smaller amount of time. Therefore, their frequency is increased, and the horn's tone sounds higher to you. As the car passes you and moves away, the process is reversed and the sound expands to fill more time. Therefore, the tone is lower."

RADAR WORKING PRINCIPLE

The radar dish or antenna transmits pulses of radio waves or microwaves that bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna that is usually located at the same site as the transmitter.

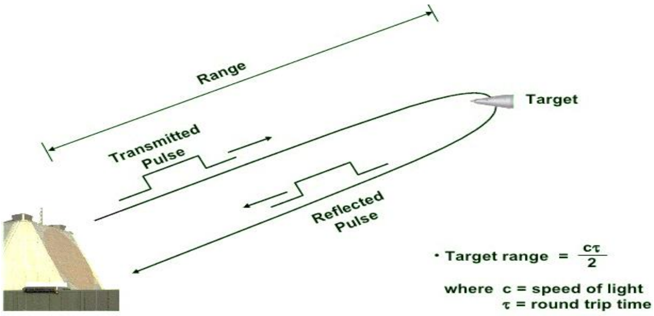

Figure 3: RADAR range measurement

IV. WHAT MAKES AN AIRCRAFT, STEALTHY?

A. The Need for Stealth

The application of radar that pushed stealth technology into existence is the radar guided anti-aircraft systems. There are several different varieties to these systems. In this system one system is to guide a turret to hit an enemy aircraft with a bullet. Such a system is shown in fig 4.

Figure 4:Anti-Aircraft Turret

Another system is to fire radar fused shells into the air. These shells emit their own radar signal and then determine the distance to planes around it. When it is close enough to a plane it explodes launching fragments in every direction. With these two types of systems, it became very dangerous to use aircraft to penetrate an enemy controlled area. The response to this deadly form of radar technology was stealth. Simply put, stealth makes it difficult for radar to detect the presence of an object in the air.

The concept behind the stealth technology is very simple. As a matter of fact, *it is totally the principle of reflection and absorption that makes aircraft "stealthy"*. Deflecting the incoming radar waves into another direction and thus reducing the number of waves does this, which returns to the radar. Design for stealth requires the integration of many techniques and materials. The types of stealth that a maximally stealthy aircraft (or other vehicle) seeks to achieve can be categorized as follows.

B. Visual Stealth

Low visibility is desirable for all military aircraft and is essential for stealth aircraft. It is achieved by colouring the aircraft so that it tends to blend in with its environment. For instance, reconnaissance planes designed to operate at very high altitudes, where the sky is black, are painted black. (Black is also a low visibility colour at night, at any altitude). Conventional daytime fighter aircraft are painted a shade of blue known as "air-superiority blue-grey," to blend in with the sky. Stealth aircraft are flown at night for maximum visual stealth, and so are painted black or dark grey. Chameleon or "smart skin" technology that would enable an aircraft to change its appearance to mimic its background is being researched. Furthermore, glint (bright reflections from cockpit glass or other smooth surfaces) must be minimized for visual stealth; this is accomplished using special coatings.

Figure 5: Visual stealth plane-hawk GB

C. Infrared Stealth

Infrared radiation (i.e., electromagnetic waves in the. 72–1000 micron range of the spectrum) are emitted by all matter above absolute zero; hot materials, such as engine exhaust gases or wing surfaces heated by friction with the air, emit more infrared radiation than cooler materials. Heat-seeking missiles and other weapons zero in on the infrared glow of hot aircraft parts. Infrared stealth, therefore, requires that aircraft parts and emissions, particularly those associated with engines, be kept as cool as possible. Embedding jet engines inside the fuselage or wings is one basic design step toward infrared stealth.

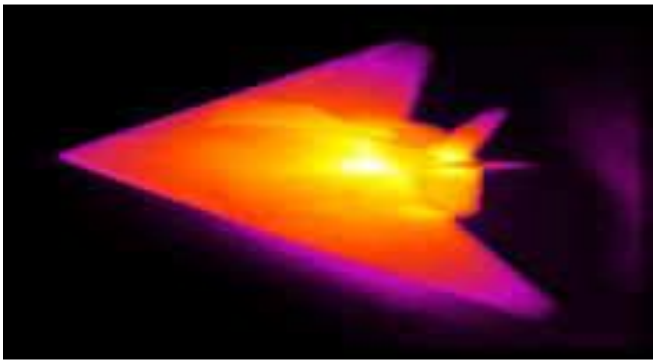

Figure 6: Thermal infrared image - US Military F117 Stealth

Other measures include extra shielding of hot parts, mixing of cool air with hot exhausts before emission; splitting of the exhaust stream by passing it through parallel baffles so that it mixes with cooler air more quickly; directing of hot exhausts upward, away from ground observers; and the application of special coatings to hot spots to absorb and diffuse heat over larger areas. Active countermeasures against infrared detection and tracking can be combined with passive stealth measures; these include infrared jamming (i.e., mounting of flickering infrared radiators near engine exhausts to confuse the tracking circuits of heat-seeking missiles) and the launching of infrared decoy flares. Combat helicopters, which travel at low altitudes and at low speeds, are particularly vulnerable to heat-seeking weapons and have been equipped with infrared jamming devices for several decades.

D. Acoustic Stealth

Although sound moves too slowly to be an effective locating signal for antiaircraft weapons, for low altitude flying it is still best to be inaudible to ground observers. Aircraft of this type are ultralight, run on small internal combustion engines quieted by silencer-suppressor mufflers, and are driven by large, often wooden propellers.

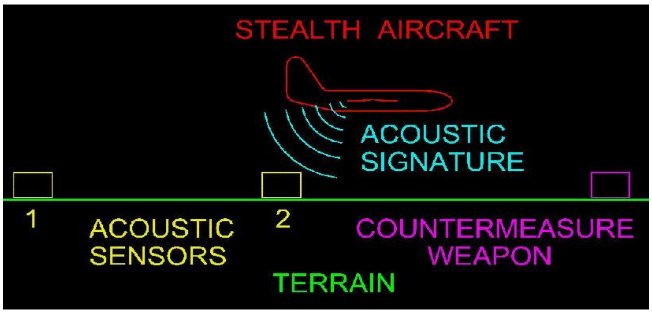

Figure 7: Acoustic Stealth Aircraft

They make about as much sound as gliders and have very low infrared emissions as well because of their low energy consumption. The U.S. F-117 stealth fighter, which is designed to fly at high speed at very low altitudes, also incorporates acoustic-stealth measures, including sound-absorbent linings inside its engine intake and exhaust cowlings.

E. Radar Stealth

RADAR is the use of reflected electromagnetic waves in the microwave part of the spectrum to detect targets or map landscapes. RADAR first illuminates the target, that is, transmits a radio pulse in its direction. If any of this energy is reflected by the target, some of it may be collected by a receiving antenna. By comparing the delay times for various echoes, information about the geometry of the target can be derived and, if necessary, formed into an image. RADAR stealth or invisibility requires that a craft absorb incident RADAR pulses, actively cancel them by emitting inverse waveforms, deflect them away from receiving antennas, or all of the above. Absorption and deflection, treated below, are the most important prerequisites of RADAR stealth. Reduction in these detection is the principle of stealth technology and it make an aircraft stealthy. There are two different ways to create invisibility:

a. *The airplane can be **Shaped (Design)** so that any radar signals it reflects are reflected away from the radar equipment.*
b. *The airplane can be covered in **Materials** that absorb radar signals (also called as Radar Absorbing Materials "**RAM**").*

F. Absorption

Metallic surfaces reflect RADAR; therefore, stealth aircraft parts must either be coated with RADAR-absorbing materials or made out of them to begin with. The latter is preferable because an aircraft whose parts are intrinsically RADAR-absorbing derives aerodynamic as well as stealth function from them, whereas a RADAR-absorbent coating is, aerodynamically speaking, dead weight. The F-117 stealth aircraft is built mostly out of a RADAR-absorbent material termed Fibaloy, which consists of glass fibers embedded in plastic, and of carbon fibers, which are used mostly for hot spots like leading wing-edges and panels covering the jet engines.

G. Deflection

Most RADAR are mono-static, that is, for reception they use either the same antenna as for sending or a separate receiving antenna collocated with the sending antenna; deflection therefore means reflecting RADAR pulses in any direction other than the one they came from. This in turn requires that stealth aircraft lack flat, vertical surfaces that could act as simple RADAR mirrors.

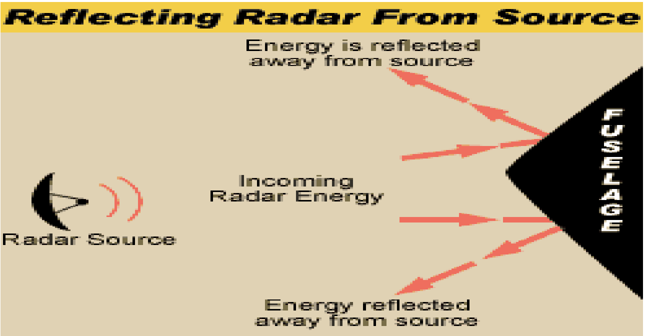

Figure 8: Deflection of Radar Because of the Stealth Design

V. STEALTH MATERIAL

Many modern military aircraft incorporate some type of surface treatment that provides radar cross section reduction to thereby transform these aircraft into "low observable" or "stealth" airplanes. Generally, these treatments employ materials that absorb or conduct incident radar energy, and typically include adhesive bonding or spray-paint-like processes for material adherence. Electromagnetic radiation absorbent/shielding materials and structures are well known. Such electromagnetic radiation absorbent/shielding materials and structures are commonly used in electromagnetic capability/electromagnetic interference (EMC/EMI) test cells to eliminate reflection and interference during testing. Electromagnetic radiation absorbent materials and structures are also utilized in electromagnetic anechoic chambers for testing high frequency radar, in antennas, and in Low Observable (LO) structures.

Radar Absorbing Material (RAM) reduces the radar cross section making the object appear smaller. These materials are both very heavy and very costly, two key limitations to their adoption for many applications. The Materials which is come under RAM is as follows

A. Iron-Ball point

One of the most commonly known types of RAM is iron ball paint. It contains tiny spheres coated with carbonyl iron or ferrite. Radar waves induce molecular oscillations from the alternating magnetic field in this paint, which leads to conversion of the radar energy into heat. The heat is then transferred to the aircraft and dissipated. The iron particles in the paint are obtained by decomposition of iron Penta carbonyl and may contain traces of carbon, oxygen and nitrogen. A related type of RAM consists of neoprene polymer sheets with ferrite grains or carbon black particles (containing about 30% of crystalline graphite) embedded in the polymer matrix.

Figure 9: Iron Carbonyl RAM

Iron ball paint has been used in coating the SR-71 Blackbird and F-117 Nighthawk, its active molecule is made up by an iron atom surrounded by five carbon monoxide molecules.

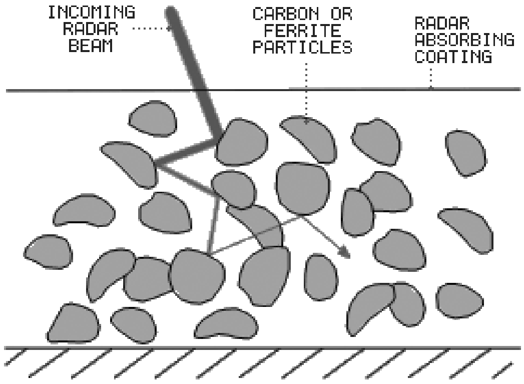

Figure 10: Incident Radar Beam Dissipated in RAM Coating

The majority of this energy is dissipated in the form of heat. The use of RAM coating is very effective but there are some drawbacks to this technology. First, the RAM coating is highly toxic. In hangers containing aircraft with RAM coatings, bats have fallen from the ceiling because of the accumulation of toxic fumes in the hanger. The second problem is that the aircraft loses some aerodynamic properties because of the paint, which causes additional heat problems. The third problem with RAM coatings is the expense. Applying the paint is a very time consuming process. The paint must be applied at a specific thickness, no bubbles can develop, and the surface of the plane cannot be compromised.

Iron ball paint (paint based on iron carbonyl) a type of paint used for stealth surface coating.

The paint absorbs RF energy in the particular wavelength used by primary RADAR.

Chemical formula: C_5FeO_5 / Fe $(CO)_5$

Molecular mass: 195.9 g/mol

Apparent density: 76.87 g/cmc

Molecular structure: An Iron atom surrounded by 5 carbon monoxide structures (it takes a ball like shape)

Melting point: 1536° C

Hardness: 82-100 HB

B. Foam Absorber

It is used as lining of anechoic chambers for electromagnetic radiation measurements. This material typically consists of fireproofed urethane foam loaded with carbon black, and cut into long pyramids. The length from base to tip of the pyramid structure is chosen based on the lowest expected frequency and the amount of absorption required. For low frequency damping, this distance is often 24 inches, while high frequency panels are as short as 3-4 inches. Panels of RAM are installed with the tips pointing inward to the chamber. Pyramidal RAM attenuates signal by two effects: scattering and absorption. Scattering can occur both coherently, when reflected waves are in-phase but directed away from the receiver, and incoherently where waves are picked up by the receiver but are out of phase and thus have lower signal strength. This incoherent scattering also occurs within the foam structure, with the suspended carbon particles promoting destructive interference. Internal scattering can result in as much as 10dB of attenuation. Meanwhile, the pyramid shapes are cut at angles that maximize the number of bounces a wave makes within the structure. With each bounce, the wave loses energy to the foam material and thus exits with lower signal strength. Other foam absorbers are available in flat sheets, using an increasing gradient of carbon loadings in different layers.

C. *Jaumann Absorber*

A Jaumann absorber or Jaumann layer is a radar absorbent device. When first introduced in 1943, the Jaumann layer consisted of two equally-spaced reflective surfaces and a conductive ground plane. One can think of it as a generalized, multi-layered Salisbury screen as the principles are similar.
Being a resonant absorber (i.e. it uses wave interfering to cancel the reflected wave), the Jaumann layer is dependent upon the $\lambda/4$ spacing between the first reflective surface and the ground plane and between the two reflective surfaces (a total of $\lambda/4 + \lambda/4$). Because the wave can resonate at two frequencies, the Jaumann layer produces two absorption maxima across a band of wavelengths (if using the two layers configuration). These absorbers must have all of the layers parallel to each other and the ground plane that they conceal. More elaborate Jaumann absorbers use series of dielectric surfaces that separate conductive sheets. The conductivity of those sheets increases with proximity to the ground plane.

VI. Radar Absorbent Surfaces (RAS)

RAS or Radar absorbent surfaces are the surfaces on the aircraft, which can deflect the incoming radar waves and reduce the detection range. RAS works due to the angles at which the structures on the aircraft's fuselage or the fuselage itself are placed. These structures can be anything from wings to a refueling boom on the aircraft. The extensive use of RAS is clearly visible in the F-117 "Night Hawk". Due to the facets (as they are called) on the fuselage, most of the incoming radar waves are reflected to another direction. Due to these facets on the fuselage, the F-117 is a very unstable aircraft.

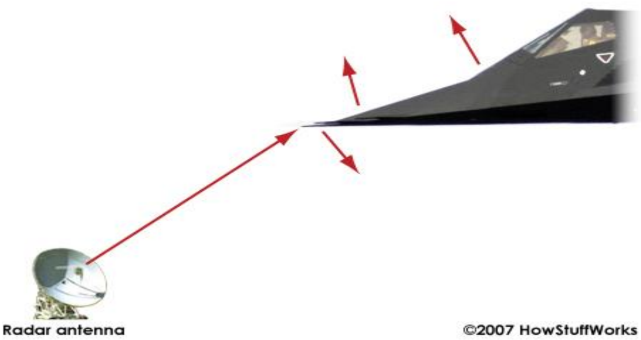

Figure 11: Stealth Aircraft

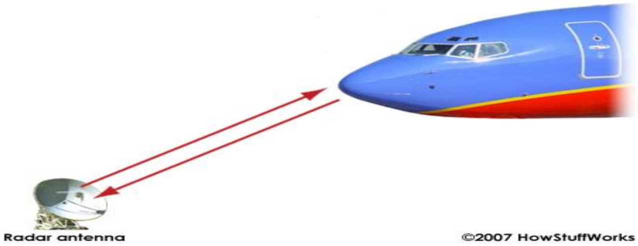

Figure 12: Conventional Aircraft

The concept behind the RAS is that of reflecting a light beam from a torch with a mirror. The angle at which the reflection takes place is also more important. When we consider a mirror being rotated from 0^o to 90^o, the amount of light that is reflected in the direction of the light beam is more. At 90^o, maximum amount of light that is reflected back to same direction as the light beam's source. On the other hand when the mirror is tilted above 90^o and as it proceeds to 180^o, the amount of light reflected in the same direction decreases drastically. This makes the aircraft like F-117 stealthy.

Figure 13: Redirected Radio Waves

The RAS is believed to be silicon based inorganic compound. The RAM coating over the B-2 is placed like wrapping a cloth over the plane. When radar sends a beam in the direction of the B-2, the radar waves are absorbed by the plane's surface and are redirected to another direction after it is absorbed. This reduces the radar signature of the aircraft. A Jaumann absorber or Jaumann layer is a radar absorbent device. The Foam absorber is applied to the chamber walls with the tips of the pyramids pointing inward or toward the radar. As a radar wave strikes a pyramid, it experiences a gradual transition from free space at the tip of the pyramid to absorbing foam at the base. The reduction in the radar cross section of material must be regarded from a complete systems point of view. That is, it is not just the use of radar absorbing material that is necessary. The shape of the object must be considered, either in the original design stage, or when radar absorbing material is applied.

VII. Radar Cross Section Reduction (RCS)

In order to understand stealth technologies it is helpful to understand how the radar cross section is calculated and what it means. According to, "The radar cross section may be considered as the projected area of an equivalent reflector which has uniform properties in all directions. This equivalent reflector is a sphere which will return the same power per unit solid angle (steradian) as the aircraft." With a sphere, the aspect angle of the radar does not affect the amount of echo energy that is received. Thus, the energy received from an aircraft's echo, at a given aspect angle, is compared to the surface area of a sphere that will produce the same amount of reflected energy.

Table 1 compares the typical RCS values of birds and insects to typical RCS values of military aircraft.

TABLE 1
RCS OF VARIOUS FLYING OBJECTS

Object	RCS [m^2]
F-15 Eagle	405
B-1A	10
SR-71 Blackbird	0.014
Birds	0.01
F-22 Raptor	0.0065
F-117 Nighthawk	0.003
B-2 Spirit	0.0014
Insects	0.001

Radar cross section is the measure of a target's ability to reflect radar signals in the direction of the radar receiver, i.e. it is a measure of the ratio of backscatter power per steradian (unit solid angle) in the direction of the radar (from the target) to the power density that is intercepted by the target. The RCS of a target can be viewed as a comparison of the strength of the reflected signal from a target to the reflected signal from a perfectly smooth sphere of cross sectional area of 1m^2 as shown in fig.

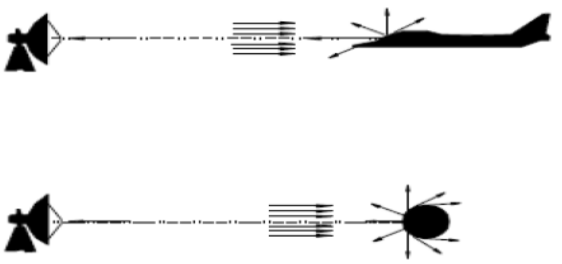

Figure 14: Concept of Radar Cross Section

The conceptual definition of RCS includes the fact that not all of the radiated energy falls on the target. A target's RCS ***(σ)*** is most easily visualized as the product of three factors:

$$\sigma = Projected\ Cross\ Section \times Reflectivity \times Directivity$$

Reflectivity: The percent of intercepted power reradiated (scattered) by the target.
Directivity: The ratio of the power scattered back in the radar's direction to the power that would have been backscattered had the scattering been uniform in all directions (i.e. isotropic ally).

VEHICLE SHAPE & DESIGN

The overall shape of an aircraft can play a significant role in reducing its radar cross-section (RCS). Research into this form of stealth technology was the first to surface. The design of the shape of the aircraft is highly dependent on the type of materials that are used for the construction of the plane. For flat, smooth objects the incident ray must be perpendicular, or normal, with the surface it is reflecting off of for radar to work. For rough surfaces, a portion of the incident ray would be directed back from any direction. For aeronautical applications, it is safe to assume that the surface will be smooth because un-smooth surfaces would have poor aerodynamic properties. With this assumption we will elaborate on spectral reflection. It should be coated with the Radar Absorbing Materials. Its tail should kept an ACUTE angle. Plane's wings has to keep at acute angle. Stealth aircraft must bury the Engines within the wing or fuselage.

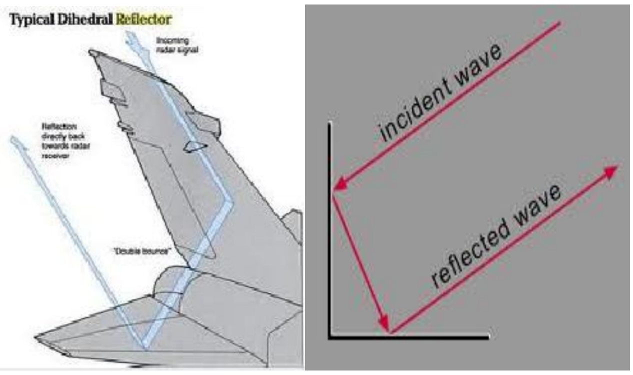

Figure 15: Design of Aircraft fins which help to reflect the waves

VIII. BENEFIT OF STEALTH TECHNOLOGY

- A smaller number of stealth aircraft may replace fleet of conventional attacks jets with the same or increased combat efficiency. Possibly resulting in longer term savings in the military budget.
- A Stealth aircraft strike capability may deter potential enemies from taking action and keep them in constant fear of strikes, since they can never know if the attack planes are already underway.
- The production of a stealth combat aircraft design may force an opponent to pursue the same aim, possibly resulting in significant weakening of the economically inferior party.
- Stationing stealth aircraft in a friendly country is a powerful diplomatic gesture as stealth planes incorporate high technology and military secrets.

IX. LIMITATIONS OF STEALTH TECHNOLOGY

- Stealth technology has its own disadvantages like other technologies. Stealth aircraft cannot fly as fast or is not manoeuvrable like conventional aircraft. The F-22 and the aircraft of its category proved this wrong up to an extent. Though the F-22 may be fast or manoeuvrable or fast, it can't go beyond Mach 2 and cannot make turns like the Su-37.
- Another serious disadvantage with the stealth aircraft is the reduced amount of payload it can carry. As most of the payload is carried internally in a stealth aircraft to reduce the radar signature, weapons can only occupy a less amount of space internally. On the other hand a conventional aircraft can carry much more payload than any stealth aircraft of its class.
- Whatever may be the disadvantage a stealth aircraft can have, the biggest of all disadvantages that it faces is its sheer cost. Stealth aircraft literally costs its weight in gold. Fighters in service and in development for the USAF like the B-2 ($2 billion), F-117 ($70 million) and the F-22 ($100 million) are the costliest planes in the world. After the cold war, the number of B-2 bombers was reduced sharply because of its staggering price tag and maintenance charges.
- The B-2 Spirit carries a large bomb load, but it has relatively slow speed, resulting in 18 to 24 hour long missions when it flies half way around the globe to attack

overseas targets. Therefore advance planning and receiving intelligence in a timely manner is of paramount importance.

- Stealth aircraft are vulnerable to detection immediately before, during and after using their weaponry. since reduced RCS bombs and cruise
- Missiles are yet not available; all armament must be carried internally to avoid increasing the radar cross section. As soon as the bomb bay doors opened, the planes RCS will be multiplied.
- Another problem with incorporating "stealth" technology into an aircraft is a wing shape that does not provide the optimum amount of lift. The resulting increase in drag reduces flight performance. "Stealth" shapes, such as the "faceting" found on Lockheed's F-117 "stealth" fighter, also tend to be aerodynamically destabilizing. This is brought under control only through the use of highly sophisticated computers that serve to electronically balance the aircraft in flight through its autopilot and control system.

All of these modifications, however, hurt the plane's performance, adding weight, affecting aerodynamics, and altering the structure of the aircraft. The advantages of stealth technology must always be weighed against its disadvantages.

X. Literature Review

The strategic importance of radar absorbing materials has resulted in a high security classification being placed in projects associated with the "stealth" concept. This has meant that the majority of reports from commercial sources and Government laboratories have been classified, with the distribution limited in most cases to the country of origin.
Because of the security attached to information concerning radar absorbing materials, the latest developments might not be included in this review and advances in the field must be gleaned by inference from the limited amount of unclassified literature that is published.

Kevin Gaylor has research on "Radar Absorbing Material-Mechanisms & Materials" and that conclude that the radar absorbing material has classified in two categories viz. *resonant absorber and broadband Absorbent. They help to control the layer thickness of the material.*

Magali Silveira Pinho, Maria Luisa Gregori and his team gives the result that magnetic absorbers tend to be heavy and the ability to provide extended frequency performance with reasonable material thickness of 1.5mm.

Paul Saville gives there review on Radar Absorbing Material that conclude that "Coatings in the form of Dallenbach layers, although not broadband, would be useful for reducing the RCS from intricate shapes. Jaumann layers would be appropriate for broadband lightweight absorbers and a genetic algorithm should be used for design optimisation. If the military is to move to composite materials for ships or super structures then frequency selective surfaces and circuit analogy absorbers should be embedded into the composite". Therefore different research has concluded their own conclusion which help to tackle the current scenario in the field of stealth technology.

XI. Conclusion

Till date stealth aircraft have been used in several low and moderate intensity conflicts, including operation Desert Storm. Undoubtedly, Stealth technology is the Future of Military Combat and at Present is one of the best technology to make things invisible as far as possible. But, the main problem with stealth is its very high cost and because of this, not all nations can adopt this technology. So as we know the material used in stealth aircraft having high cost so we can use the composite material or smart material while the using of costly material. That reduces the cost of the material. An advance in one field, such as materials or aerodynamics, must be accompanied by advances in other fields, such as computing or electromagnetic theory. The second lesson is that sometimes trial and error techniques are insufficient and advances in mathematical theory are necessary in order to achieve significant advances. Finally, stealth teaches the lesson that technology is never static-a "stealth breakthrough" may only last for a few years before an adversary finds a means of countering it. Finally we conclude that the future of the stealth technology is not only in air, it perform under the water as well as on the land also which helps to increase the strength of the nation in defense sector.

Resources

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Bipin Kumar Jha Third Year in Mechanical Engineering, Guru Gobind Singh College of Engineering & Research Centre, Nashik

Mayur Somnath Aswale Third Year in Mechanical Engineering, Guru Gobind Singh College of Engineering & Research Centre, Nashik