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NANO ENABLED COATINGS MAKES AIRCRAFT INVISIBLE

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Abstract: Nowadays, there is special need hiding the Aircraft from the enemies so, this technology will do it for us. This modern technology will change the world, as we are moving beyond our boundaries there is need of this technology when we were facing alien from other world. This Nano Enabled Coating makes Aircraft invisible to RADAR. This coating of titanium dioxide absorbs the RADAR waves. Nano-particles have a large surface area-to-volume ratio and high surface energy which is utilized to hide Aircraft from RADAR. As it also absorbs the light waves Aircraft seems partially invisible to naked eyes.

Keywords: TiO_2, Nano Coating, Invisible Aircraft Technology

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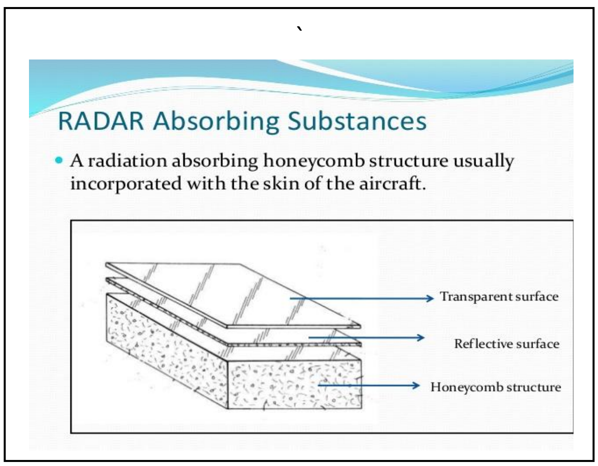
INTRODUCTION

The technology of making Aircraft invisible is by using the nano coating of Titanium dioxide.Titanium dioxide occurs in nature as well-known minerals rutile, anatase and brookite, and additionally as two high pressure forms, a monoclinic baddeleyite-like form and an orthorhombic α-PbO_2-like form, both found recently at the Ries crater in Bavaria. It is mainly sourced from ilmenite ore. . Approved by the United States Food and Drug Administration (FDA), it is considered a safe substance that is harmless to humans. The photo catalytic properties of titanium dioxide were discovered by Akira Fujishima in 1967 and published in 1972.

Titanium dioxide (TiO_2) is a white solid inorganic substance that is thermally stable, non-flammable, poorly soluble, and not classified as hazardous according to the United Nations' (UN) Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

TiO_2, the oxide of the metal titanium, occurs naturally in several kinds of rock and mineral sands. Titanium is the ninth most common element in the earth's crust. TiO_2 is typically thought of as being chemically inert.



Titanium dioxide has been used for many years (ca. 90 years) in a vast range of industrial and consumer goods including paints, coatings, adhesives, paper and paperboard, plastics and rubber, printing inks, coated fabrics and textiles, catalyst systems, ceramics, floor coverings, roofing materials, cosmetics and pharmaceuticals, water treatment agents, food colorants and in automotive products, etc …

The main features of TiO_2 are as per our requirement are resemble in following ways

1) Due to its high diffraction index and strong light scattering and incident-light reflection capability, TiO_2 is mostly used as white pigment.

2) The production volume of nanoscale TiO_2 amounts to less than 1 percent that of TiO_2 pigments.

3) High sun protection factors can only be achieved using nano scale titanium dioxides.

4) The photocatalytic activity, which is another property of TiO_2, is increased considerably through the high surface-to-volume ratio of the nanoparticles as compared to that of microparticles.

5) Due to the hydrophilic character of titanium dioxide, water forms a closed film on the surface in which pollutants and degradation products can be easily carried away. House paints or tiles containing TiO_2 particles thus are self-cleaning and pollutant-degrading.

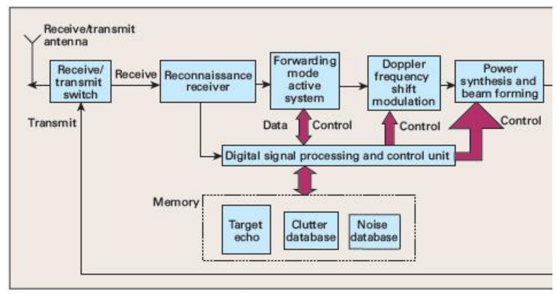
6) Nanoscale titanium dioxides are also suited for use in dye-sensitized solar cells (Graetzel cells).

7) It absorbs UV light. When TiO_2 pigment is incorporated in a polymer, it minimizes degradation of the system(embrittlement, fading and cracking). Surface treating of the TiO_2 can further improve this property.

8) TiO_2 as a nanomaterial (ultrafine) appears transparent whilst still providing UV light absorption.

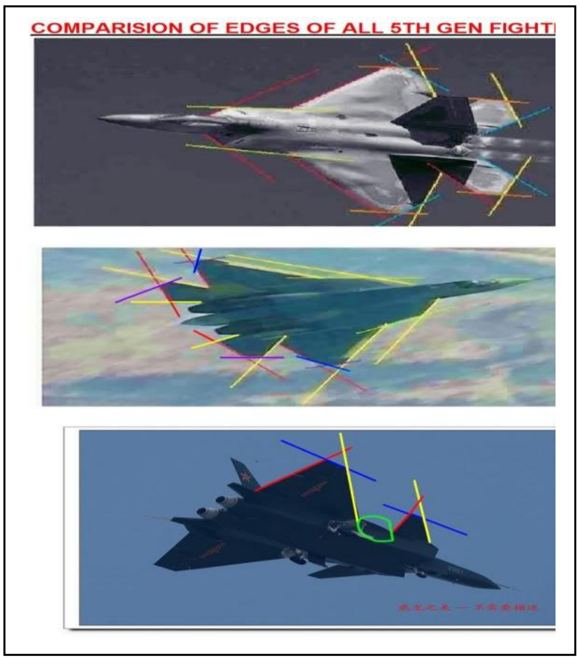
Working of Nano Enabled Coating on Aircraft:

The working of Titanium Dioxide coating on Aircraft can be described in simple manner as it has the property to absorb the RADAR waves, Radar is something that is in use all around us, although it is normally invisible. Air traffic control uses radar to track planes both on the ground and in the air, and also to guide planes in for smooth landings. Police use radar to detect the speed of passing motorists. NASA uses radar to map the Earth and other planets, to track satellites and space debris and to help with things like docking and maneuvering. The military uses it to detect the enemy and to guide weapons.

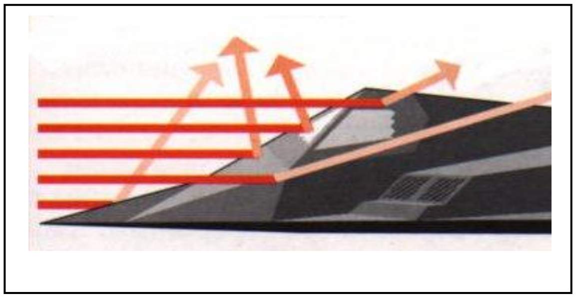


2.This diagram illustrates the basic function blocks in the active cancellation stealth system.

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, which returns to the radar? Another concept that is followed is to absorb the incoming radar waves totally and to redirect the absorbed electromagnetic energy in another direction. Whatever may be the method used, the level of stealth an aircraft can achieve depends totally on the design and the substance with which it is made of. The idea is for the radar antenna to send out a burst of radio energy, which is then reflected back by any object it happens to encounter. The radar antenna measures the time it takes for the reflection to arrive, and with that information can tell how far away the object is.



A stealth aircraft, on the other hand, is made up of completely flat surfaces and very sharp edges. When a radar signal hits a stealth plane, the signal reflects away at an angle, like this:



In addition, surfaces on a stealth aircraft can be treated so they absorb radar energy as well. The overall result is that a stealth aircraft like an F-117A can have the radar signature of a small bird rather than an airplane. The only exception is when the plane banks -- there will often be a moment when one of the panels of the plane will perfectly reflect a burst of radar energy back to the antenna.

RAS (RADAR ABSORBENT SURFACES).

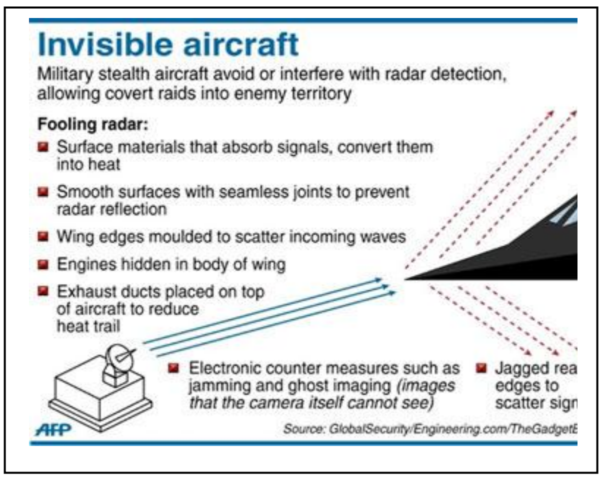
RAS (Radar Absorbent Surfaces) are the surfaces on the aircraft, which can deflect the incoming radar waves and reduce the detection range. RAS works due to the angles at which the structures on the aircraft's fuselage or the fuselage itself are placed. These structures can be anything from wings to 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.

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. RADAR ABSORBENT MATERIALS (RAM) Radar absorbent surfaces absorbs the incoming radar waves rather than deflecting it in another direction. RAS totally depends on the material with which the surface of the aircraft is made. Though the composition of this material is a top secret.The F-117 extensively uses RAM to reduce its radar signature or its radar cross section.

The RAS is believed to be silicon based inorganic compound. This is assumed by the information that the RAM coating on the B-2 is not water proof. This is just a supposition and may not be true. What we know is that 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.

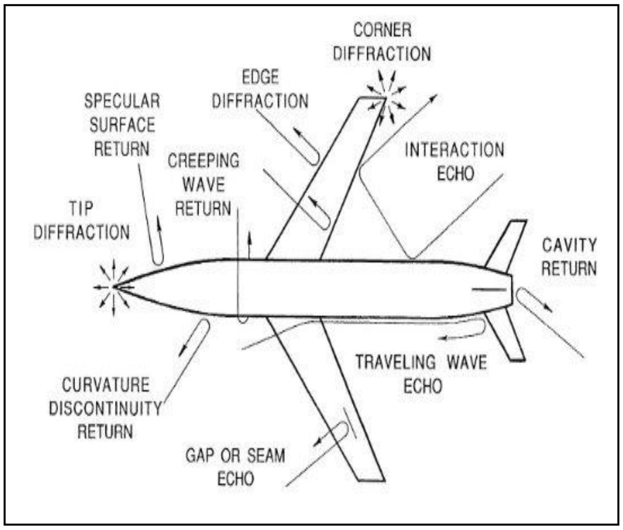
INFRARED (IR)

Another important factor that influences the stealth capability of an aircraft is the IR (infrared) signature given out by the plane. Usually planes are visible in thermal imaging systems because of the high temperature exhaust they give out. This is a great disadvantage to stealth aircraft as missiles also have IR guidance system. The IR signatures of stealth aircraft are minute when compared to the signature of a conventional fighter or any other military aircraft. If reducing the radar signature of an aircraft is tough, then reducing the IR signature of the aircraft is tougher. It will be like flying a plane with no engines. The reduced IR signature totally depends on the engine and where the engine is placed in an aircraft.

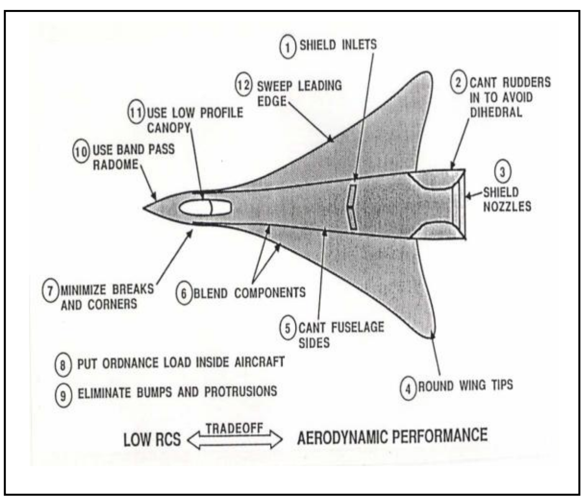


Technology behind this is top secret like others in stealth aircraft. Another main aspect that reduces the IR signature of a stealth aircraft is to place the engines deep into the fuselage. This is done in stealth aircraft like the B-2, F-22 and the JSF. The IR reduction scheme used in F-117 is very much different from the others. The engines are placed deep within the aircraft like any stealth aircraft and at the outlet, a section of the fuselage deflects the exhaust to another direction. This is useful for deflecting the hot exhaust gases in another direction.

METHODS OF AVOIDING DETECTION



There are some more methods by which planes can avoid detection. These methods do not need any hi-tech equipment to avoid detection. Some of them have been used for years together by pilots to avoid detection. One of the main efforts taken by designers of the stealth aircraft of today is to carry the weapons payload of the aircraft internally. This has shown that carrying weapons internally can considerably decrease the radar cross-section of the aircraft. Bombs and Missiles have a tendency to reflect the incoming radar waves to a higher extent. Providing missiles with RAM and RAS is impossible by the cost of these things. Thus the missiles are carried in internal bombays which are opened only when the weapons are released. Aircraft has used another method of avoiding detection for a very long time. Ground Radars can use the radar waves or electro-magnetic energy of planes radar and locate it. An aircraft can remain undetected just by turning off his radar.



In case of some of the modern stealth aircraft, it uses its wingman in tandem to track its target and destroy it. It is done in the following way. The fighter, which is going to attack moves forward, the wingman (the second aircraft) on the other hand remains at a safe distance from the target which the other fighter is approaching. The wingman provides the other fighter with the radar location of the enemy aircraft by a secured IFDL (In Flight Data Link). Thus the enemy radar is only able to detect the wingman while the attacking fighter approaches the enemy without making any sharp turns. This is done not to make any sudden variations in a stealth aircraft's radar signature. Thus the 9 fighter, who moves forward, is able to attack the enemy without being detected.

Advantages:

1) Aircraft invisible to RADAR.

2) It absorbs UV light. When TiO_2 pigment is incorporated in a polymer, it minimizes degradation of the system (embrittlement, fading and cracking). Surface treating of the TiO_2 can further improve this property.

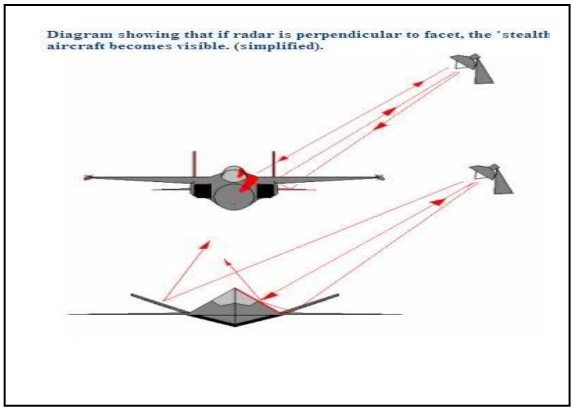
3) When used in paint or coating system, this effect ensures the longevity of the paint and the continued protection of the substrate.

4) In exterior applications the coolness conferred by TiO_2 colored surfaces leads to considerable energy savings in warm and tropical area by light reflectance thus reducing the need for air-conditioning.

5) The weapon itself becomes less vulnerable to enemy defensive systems, which means that fewer of the weapons launched will be shot down before reaching their target(s).

6) A greater number of targets can be confidently engaged with a given force.

7) The other benefit is the advantage of surprise and its effect in cases where shrinking the enemy as available reaction time is of the essence.



1) Instability of design

Early stealth aircraft were designed with a focus on minimal radar cross section (RCS) rather than aerodynamic performance. Highly-stealth aircraft like the F-117 Nighthawk are aerodynamically unstable in all three axes and require constant flight corrections from a fly-by-wire (FBW) flight system to maintain controlled flight. As for the B-2 Spirit, which was based on the development of the flying wing aircraft by Jack Northrop in 1940, this design allowed for a stable aircraft with sufficient yaw control, even without vertical surfaces such as rudders.

2)Aerodynamic limitations

Earlier stealth aircraft (such as the F-117 and B-2) lack afterburners, because the hot exhaust would increase their infrared footprint, and breaking the sound barrier would produce an obvious sonic boom, as well as surface heating of the aircraft skin which also increased the infrared footprint. As a result their performance in air combat maneuvering required in a dogfight would never match that of a dedicated fighter aircraft. This was unimportant in the case of these two aircraft since both were designed to be bombers. More recent design techniques allow for stealthy designs such as the F-22 without compromising aerodynamic performance. Newer stealth aircraft, like the F-22, F-35 and the Sukhoi T-50, have performance characteristics that meet or exceed those of current front-line jet fighters due to advances in other technologies such as flight control systems, engines, airframe construction and materials.

3)Electromagnetic emissions

The high level of computerization and large amount of electronic equipment found inside stealth aircraft are often claimed to make them vulnerable to passive detection. This is highly unlikely and certainly systems such as Tamara and Kolchuga, which are often described as counter-stealth radars, are not designed to detect stray electromagnetic fields of this type.

Such systems are designed to detect intentional, higher power emissions such as radar and communication signals. Stealth aircraft are deliberately operated to avoid or reduce such emissions.

Current Radar Warning Receivers look for the regular pings of energy from mechanically swept radars while fifth generation jet fighters use Low Probability of Intercept Radars with no regular repeat pattern.

4)Vulnerable modes of flight

Stealth aircraft are still vulnerable to detection during, and immediately after using their weaponry. Since stealth payload (reduced RCS bombs and cruise missiles) are not yet generally available, and ordnance mount points create a significant radar return, stealth aircraft carry all armament internally. As soon as weapons bay doors are opened, the plane's RCS will be multiplied and even older generation radar systems will be able to locate the stealth aircraft. While the aircraft will reacquire its stealth as soon as the bay doors are closed, a fast response defensive weapons system has a short opportunity to engage the aircraft.

This vulnerability is addressed by operating in a manner that reduces the risk and consequences of temporary acquisition. The B-2's operational altitude imposes a flight time for defensive weapons that makes it virtually impossible to engage the aircraft during its weapons deployment. New stealth aircraft designs such as the F-22 and F-35 can open their bays, release munitions and return to stealthy flight in less than a second.

Some weapons require that the weapon's guidance system acquire the target while the weapon is still attached to the aircraft. This forces relatively extended operations with the bay doors open.

Also, such aircraft as the F-22 Raptor and F-35 Lightning II Joint Strike Fighter can also carry additional weapons and fuel on hard points below their wings. When operating in this mode the planes will not be nearly as stealthy, as the hard points and the weapons mounted on those hard points will show up on radar systems. This option therefore represents a tradeoff between stealth or range and payload. External stores allow those aircraft to attack more targets further away, but will not allow for stealth during that mission as compared to a shorter range mission flying on just internal fuel and using only the more limited space of the internal weapon bays for armaments.

5) Reduced payload

In a 1994 live fire exercise near Point Mugu, California, a B-2 Spirit dropped forty-seven 500 lb (230 kg) class Mark 82 bombs, which represents about half of a B-2's total ordnance payload in Block 30 configuration.

Fully stealth aircraft carry all fuel and armament internally, which limits the payload. By way of comparison, the F-117 carries only two laser or GPS guided bombs, while a non-stealth attack aircraft can carry several times more. This requires the deployment of additional aircraft to engage targets that would normally require a single non-stealth attack aircraft. This apparent disadvantage however is offset by the reduction in fewer supporting aircraft that are required to provide air cover, air-defense suppression and electronic counter measures, making stealth aircraft "force multipliers".

6) Sensitive skin:

Stealth aircraft often have skins made with Radar-absorbent materials or RAMs. Some of these contain Carbon black particles, some contain tiny iron spheres. There are many materials used in RAMs, and some are classified, particularly the materials that specific aircraft use.

7) Cost of operations

Stealth aircraft are typically more expensive to develop and manufacture. An example is the B-2 Spirit that is many times more expensive to manufacture and support than conventional bomber aircraft. The B-2 program cost the U.S. Air Force almost $45 billion.

Conclusion:

The optical behavior of the films was investigated at room temperature. It has been found that all the films were highly transparent; they showed high transmission in the visible region of the spectrum, which reveals relatively high surface smoothness without abnormal grain growth. The property of being invisible to RADAR and observing the UV rays is very good.

REFERENCE:

1. Stealth Technology Page. http://iron-eagles.tripod.com/stp.htm

2. Items 17 Stealth. www.fas.org/nuke/control/mtcr/ text/mtcr_handbook_item17.pdf

3. Fiber Radio Optical ARCS. http://iron-eagles.tripod.com/articles/fiber_radio_optical_arcs.htm

4. Perspectives on Plasma. http://www.plasmas.org/basics.htm

5. Russians offer radical stealth device for export, Jane's Defence Wekly, March 17, 1999, p. 52

6. Boffetta P, Gaborieau V, Nadon L, Parent M-E, Weiderpass E, Siemiatycki J. (2001). Exposure to titanium dioxide and risk of lung cancer in a population-based study from Montreal. Scand. J. Work Environ. Health 27:227-232.

7. Boffetta P., Soutar A., Cherrie J., Granath F., Andersen A., Anttila A., Blettner M., Gaborieau V., Klug S., Langard S., Luce D., Merletti F., Miller B., Mirabelli D., Pukkala E., Adami H-O., and Weiderpass E. (2004). Mortality among workers employed in the titanium dioxide industry in Europe. Cancer Causes and Control 15(7):697-706.

8. Chen J, and Fayerweather W. (1988). Epidemiologic study of workers exposed to titanium dioxide. J. Occup. Med. 30(12):937-42.

9. Fryzek J, Chadda B, Marano D, White K, Schweitzer S, McLaughlin J, and Blot W. (2003). A cohort mortality study among titanium dioxide manufacturing workers in the United States. J. Occup. Environ. Med. 45(4):400-09.

10. Gamer, A. O.; et al. (2006). The in vitro absorption of microfine zinc oxide and titanium dioxide through porcine skin. Toxicology in Vitro 20, 301-307.

11. O. O. Adewoye, "Advances in Engineering Materials De- velopment," Proceedings of Nigeria Materials Congress, Ile-Ife, 14-17 November 2007, pp. 118-122.

12. C. X. Shan, X. Hou and K. Choy, "Corrosion Resistance of TiO2 Films Grown on Stainless Steel by Atomic Layer Deposition," Surface and Coatings Technology, Vol. 202, No. 11, 2008, pp. 2399-2402.

13. Z. L. Tang, J. Y. Zhang, Z. Cheng and Z. T. Zhang, "Syn- thesis of Rutile TiO2 at Low Temperature," Materials Chemistry and Physics, Vol. 77, No. 2, 2001, pp. 314-317.

14. J. C. Yu, J. G. Yu, L. Z. Zhang and W. K. Ho, "Photo- catalytic Activity of Nano-Sized TiO2 Powders by Sol- Gel Method, Using Titanium Tetraisopropoxide and EtOH/ H2O Solution," Journal of Photochemistry and Photobi- ology A: Chemistry, Vol. 148, No. 1-3, 2002, pp. 263-271.

15. Latroche, M; Brohan, L; Marchand, R; Tournoux, (1989). "New hollandite oxides: TiO_2(H) and $K_{0.06}TiO_2$". Journal of Solid State Chemistry 81 (1): 78–82. Bibcode:1989JSSCh..81...78L. doi:10.1016/0022-4596(89)90204-1.

16. Sato H. , Endo S, Sugiyama M, Kikegawa T, Shimomura O, Kusaba K (1991). "Baddeleyite-Type High-Pressure Phase of TiO_2". Science 251 (4995): 786–788. Bibcode:1991Sci...251..786S