



BSI Standards Publication

Space engineering — Structural materials handbook

Part 8: Glossary

National foreword

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**Space engineering - Structural materials handbook - Part
8: Glossary**

Ingénierie spatiale - Manuel des matériaux structuraux
- Partie 8 : Glossaire

Raumfahrttechnik - Handbuch der
Konstruktionswerkstoffe - Teil 8: Glossar

This Technical Report was approved by CEN on 29 November 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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European Foreword

This document (CEN/TR 17603-32-08:2022) has been prepared by Technical Committee CEN/CLC/JTC 5 "Space", the secretariat of which is held by DIN.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN 16603-32.

This Technical report (CEN/TR 17603-32-08:2022) originates from ECSS-E-HB-32-20 Part 8A.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

Introduction

The Structural materials handbook is published in 8 Parts.

A glossary of terms, definitions and abbreviated terms for these handbooks is contained in Part 8.

The parts are as follows:

TR 17603-32-01	Part 1	Overview and material properties and applications	Clauses 1 - 9
TR 17603-32-02	Part 2	Design calculation methods and general design aspects	Clauses 10 - 22
TR 17603-32-03	Part 3	Load transfer and design of joints and design of structures	Clauses 23 - 32
TR 17603-32-04	Part 4	Integrity control, verification guidelines and manufacturing	Clauses 33 - 45
TR 17603-32-05	Part 5	New advanced materials, advanced metallic materials, general design aspects and load transfer and design of joints	Clauses 46 - 63
TR 17603-32-06	Part 6	Fracture and material modelling, case studies and design and integrity control and inspection	Clauses 64 - 81
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TR 17603-32-08	Part 8	Glossary	

1 Glossary

A

A

Aluminium Association, USA

A-BASIS DESIGN ALLOWABLE

A value which at least 99% of the population of values is expected to fall with a confidence of 95%, Ref. [9]; also known as 'A' value and 'A' basis.

A-SCAN

A single point signal describing the ultrasonic response of material immediately beneath the transducer

A-stage

An early stage in the polymerisation reaction of certain thermo-setting resins (especially phenolic) in which the material, after application to the reinforcement, is still soluble in some liquids and is fusible; sometimes called resole. [See also: B STAGE, C STAGE]

'A' value

An 'A' value is one above which at least 99% of the population of values is expected to fall with a confidence of 95%. [See also: ALLOWABLES]

ABLATIVE

Sacrificial material which protects a structure from high-velocity, high-temperature gas streams. It is typically used on leading surfaces for planetary re-entry to protect against frictional atmospheric heating. The surface of the ablative is consumed by reaction, abrasion and evaporation or sublimation and the lost material carries heat away from the underlying structure

AblaDor DO-31-F

Lightweight phenolic ablative

ABM

Apogee Boost Motor

ABS

- 1 Alumino-boro-silicate ceramic
- 2 Acrylonitrile-butadiene-styrene copolymer

ACC

Advanced Carbon-Carbon (NASA) replaced RCC

ACCELERATOR

A material mixed with a catalysed resin to increase the rate of chemical reaction between the catalyst and resin, used in polymerising resins, also known as promoter or curing agent

ACCELEROMETER

A device for measuring acceleration, often used in vibration analysis

ACCEPTANCE

Verification phase with the objective to demonstrate that the flight items are free of workmanship defects and integration errors and ready for operational use, Ref. [1]

ACESA

Advanced composites with embedded sensors and actuator. An American smart technology programme.

ACG

Advanced Composites Group, UK

ACK analysis

Aveston-Cooper-Kelly analysis for modelling the onset of matrix cracking in composite materials (with particular regard to CMC ceramic matrix composites)

ACOUSTIC EMISSION (AE)

An inspection technique where the sound generated by damage formation and propagation (under test stressing or in-service) is monitored using sensitive, high-frequency microphones. Triangulation techniques can be used to locate the damage events within a three dimensional structure. Frequently used to measure the integrity of composite laminates

ACRV

Assured Crew Return Vehicle (NASA/ESA) for emergency return of astronauts from orbiting space stations to earth

ACS

Attitude Control System

ACTEX

Advanced control technology experiment. An American smart technology programme.

ACTIVE COMPENSATION

A device able to change its characteristics in response to an externally triggered signal, e.g. stiffness in response to vibration

ACUSIL I

An ablative foam composed of silicone resin, quartz microballoons, phenolic microballoons and quartz fibre

ACUSIL II

Lower density ablative foam composed of silicone resin, quartz microballoons, phenolic microballoons and quartz fibre. Remains RF transparent during re-entry

ADHEREND

Plate adhesively bonded to another plate, Ref. [10].

ADHESION

The state in which two surfaces are held together at an interface by forces or the interlocking action of an adhesive or both

ADHESIVE

A substance capable of holding two surfaces together

ADVANCED COMPOSITES

Composite materials with structural properties comparable to or better than those of aluminium; e.g. boron, graphite and aramid composites

AE

See: Acoustic Emission

AECMA

Association Européen des Constructeurs Matériel Aérospatiale; European Association of Aerospace Industries

AEFIS

Acoustic emission flight instrumentation system. A structural health monitoring system, developed by Boeing.

Aerotiss® 2.5D

Aerospatiale reinforced carbon-carbon (RCC) material with multidirectional fibre architecture

A_f

Austenite finish temperature

AFNOR

Association Française de Normalisation; French national standards organisation

AFRSI

Advanced Flexible Reusable Surface Insulation (Shuttle orbiter)

AFWAL

Air Force Wright Aeronautical Laboratory, USA

AGC

Attitude Gain Control

AGE HARDENING

A thermal treatment used to improve the strength of some metal alloys, e.g. certain aluminium alloys, [See also: Precipitation Hardening].

AGED STRUCTURE

A structure which can have structural degradation or damage as a result of being exposed to the combined effects of the environment

AGEING

General: The process or the effect on materials of exposure to an environment (elevated temperature, ultraviolet radiation, moisture or other hostile environment) for a period of time; also known as ‘aging’

1 Material or sample: usually undertaken before testing and applied to simulate the expected service environmental conditions, e.g. exposure to heat and humidity

2 Structure: the progressive change in characteristics owing to exposure to the service conditions, e.g. corrosion, outgassing

3 Processing: a thermal process used to obtain the desired microstructure and properties of metal alloys, e.g. some aluminium alloys

AGGRESSIVE ENVIRONMENT

Any combination of liquid or gaseous media and temperature that alters static or fatigue crack-growth characteristics from ‘normal’ behaviour associated with an ambient temperature and laboratory air environment, Ref. [5]

AGING

[See: Ageing].

AI

Artificial intelligence

AIAA

American Institute of Astronautics and Aeronautics, USA

AISI

American Iron and Steel Institute

AIT

Assembly, Integration and Test

AIV

Assembly, Integration and Verification

AKM

Apogee Kick Motor

ALFLEX

Automatic Landing Experimental Vehicle

Al-Li

Aluminium-lithium alloy

ALLOTROPY

Existence of a chemical element in two or more physical forms, e.g. carbon as graphite or diamond

ALLOWABLE LOAD

The load that induces the allowable stress in a material, Ref. [5]

ALLOWABLE STRESS

The maximum stress that can be permitted in a material for a given operating environment to prevent rupture, collapse, detrimental deformation or unacceptable crack growth, Ref. [5]

ALLOWABLES

Material values that are determined from test data at the laminate or lamina level on a probability basis (e.g. 'A' or 'B' values), following ASTM or other test standards accepted by the final customer. [See also: A-BASIS DESIGN ALLOWABLE; B-BASIS DESIGN ALLOWABLE; 'A' VALUE, 'B' VALUE]

ALLOY

Mixture of a base metallic element with one or more other metallic or non-metallic elements

AlN

Aluminium nitride

ALS051

Medium-density, silicone-based ablative

ALSCAP

Alternative Low-cost, Short Manufacturing Cycle Assessment Programme

ALUMINA

Aluminium Oxide, Al₂O₃.

ALUMINIDE

Intermetallic compound of another metallic element, or elements, with aluminium, e.g. NiAl, TiAl or FeAl

ALUMINIUM (Al)

Metallic element, melting point 660°C, density 2700 kg m⁻³. Uses: ubiquitous aerospace alloy base, important component in oxidation resistant alloys and coatings and as part of basic strengthening mechanism for nickel-based superalloys

ALUMINIUM-LITHIUM

An aluminium alloy containing typically between 1% and 3% Li, with the objective of increasing mechanical properties over base alloy alone.

Note: Because Li is a low-level alloy addition, Al-Li alloys are classified within the 2XXX, 7XXX and 8XXX wrought alloy designations, plus 2XX casting alloys

ALUMINIUM NITRIDE (AlN)

Ceramic with high thermal conductivity (140 W/mK to 177 W/mK), but is effectively an electrical insulator (volume resistivity 1010 ohm cm). Can suffer surface oxidation above 700°C, density 3320 kg m⁻³.

ALUMINO-SILICATE

Compound of aluminium and silicon oxides used in ceramics and some types of glasses for composite matrix materials

AMBIENT

- 1 The surrounding environmental conditions, e.g. pressure, temperature or relative humidity
- 2 usual work place temperature and humidity environmental conditions, e.g. room temperature

ANALYSIS

A verification method performing theoretical or empirical analysis by accepted analytical methods. The selected techniques can typically include systematics, statistics, qualitative design analysis, modelling and computer simulation, Ref. [1]

ANALYSIS PROCEDURE

This document lists all the requirements to be verified by Analysis, grouping them in categories detailing the Verification Plan activity sheets, with planning of the execution and a definition of the associated procedures, Ref. [1]

ANALYSIS REPORT

A document that describes, for each analysis, assumptions, utilised methods, software and results and contains proper evidence that the relevant requirements are satisfied, Ref.[1]

ANALYTICAL LIFE

Life evaluated analytically, i.e. by crack-growth analysis or fatigue analysis, Ref. [5]

ANALYTICAL MODEL

A representation of an item based on mathematical modelling. The modelling is performed on the basis of known mathematical techniques, providing a representation of the item features under investigation, Ref. [1]

ANGLE INTERLOCKED

A triaxial fabric in which all reinforcement fibres are woven at the same time; also known as 'integrally woven'

ANGLE-PLY LAMINATE

Possessing equal plies with positive and negative angles. This bidirectional laminate is simple because it is orthotropic

ANISOTROPIC

Having mechanical or physical properties which vary in direction relative to natural reference axes in the material

ANNEALING

A heat treatment process:

- 1 Metals: used to reduce residual stresses.
- 2 Composites: ineffective at reducing residual stresses

ANOXIC

The resistance of a material to thermo-oxidative attack by atomic oxygen

ANTISYMMETRY

Special symmetry with sign change between off-diagonal components, e.g. an unsymmetrical angle-ply laminate

AO

Atomic oxygen; experiments conducted on the Long Duration Exposure Facility (LDEF)

AOCS

Attitude and Orbit Control System, or subsystem

APC

Aromatic polymer composite

AQUEOUS CORROSION

Corrosion by ionic species in water, e.g. chlorides, hydroxides. Includes moisture or humidity trapped or condensed within structures.

AR

Acceptance Review

ARA

Advanced rigid array; a type of ultrasonic transducer assembly

ARALDITE™

A range of epoxy-based structural adhesives; developed by Ciba Geigy, now Vantico

ARALL™

Aramid fibre-reinforced aluminium laminate. [See: FIBRE METAL LAMINATE]

ARAMID

A type of highly oriented aromatic polymer material. Used primarily as a high-strength reinforcing fibre, of which Kevlar™ 49 and Twaron™ HM are most commonly used in aerospace applications

ARAMID/EPOXY

A composite material comprising of an aramid fibre reinforcement in an epoxy matrix

ARC

Austrian Research Centre, Seibersdorf

ARD

Atmospheric Re-entry Demonstrator

AREAL WEIGHT

A measurement of the weight per unit area of a fabric or fabric prepreg; expressed as g/m²

ARIANE

Family of European launch vehicles

ARP

Aramid fibre-reinforced plastic, Ref. [10]

ARTIFICIAL INTELLIGENCE (AI)

The property of a machine capable of reason by which it can learn functions normally associated with human intelligence

A_s

Austenite start temperature

ASIFS

Aerial spacecraft interface structure; part of SILEX

ASIP

Aircraft Structural Integrity Program

ASME

American Society of Mechanical Engineers

ASSEMBLED ARTICLE

Any component 'black box' or assembly of components which represents the article to be used in a spacecraft, Ref. [7].

ASSEMBLY

An accumulation of subassemblies and/or equipment that performs specific functions within a subsystem, e.g. water pump package. (Verification level typical of US standard), Ref.[1]

ASTM

American Society for Testing and Materials; USA standards organisation

ASTP

Advanced Systems and Technology Programme; ESA programme

ASTREX

Advanced space structure technology research experiments; an American smart technology programme

ATC

- 1 Active Thermal Control
- 2 Advanced Technical Ceramic

ATOMISATION

Spray technique for producing metal alloy powders with or without a particulate reinforcement. Molten metal is forced through a nozzle into a stream of high-velocity, inert gas. The semi-solid droplets are collected on a substrate. Proprietary processes are OSPREY (un-reinforced alloys) and COSPRAY (particulate reinforced alloys)

ATOX

Atomic Oxygen

AUTOCLAVE

A closed vessel for conducting a chemical reaction or other operation under pressure and heat

AUTOCLAVE MOULDING

After composite lay-up, the entire assembly is placed in steam autoclave at 7 bar to 14 bar and 180°C; additional pressure achieves higher reinforcement loading and improved removal of air

AVCO 5026-39 HCG

Epoxy-novalac, glass fibre honeycomb reinforced material

AVERAGE STRESS CRITERION

A failure criterion in which it is assumed that failure occurs when the average stress over some distance equals the unnotched laminate strength

AWG

American Wire Gauge

AXIAL WINDING

In filament-wound reinforced plastics, a winding with the filaments parallel to the axis

AXISYMMETRY

Symmetry about an axis (in the case of a laminated material it is isotropic in the plane normal to the axis, and this material is called transversely isotropic)

B

B-BASIS DESIGN ALLOWABLE

A value which at least 90 % of the population of values is expected to fall with a confidence of 95 %, Ref. [9]; also known as 'B' value

B-SCAN

A scanned line response showing features at identifiable depths; nondestructive testing

B-STAGE

An intermediate stage in the reaction of certain thermosetting resins, Ref. [10], in which the material swells when in contact with certain liquids and softens when heated, but cannot dissolve or fuse entirely; sometimes referred to as 'resistol'. The resin in an uncured prepreg or pre-mix is usually in this stage. [See also: A-STAGE, C-STAGE]

'B' VALUE

A 'B' value is that above which at least 90% of the population of values is expected to fall with a confidence of 95%. [See also: ALLOWABLES]

BACKING SHEET

A thin polymer sheet used to protect prepreg and film adhesive surfaces from contamination and damage prior to use. These have to be completely removed during lay-up and are usually coloured to aid this.

BAe

British Aerospace, UK

BAGGING

Process: the enclosing of an uncured composite lay-up in a heat-resistant bag prior removal of the air and subsequent curing

BAKEOUT

Activity of increasing the temperature of hardware to accelerate its outgassing rates with the intent of reducing the content of molecular contaminants within the hardware. Note: Bakeout is usually performed in a vacuum environment but may be done in a controlled atmosphere, Ref. [8].

BALANCED DESIGN

In filament-wound reinforced plastics, a winding pattern so designed that the stresses in all filaments are equal

BALANCED LAMINATE

Where plies with positive angles are balanced by equal plies with negative angles. While angle-ply laminates have only one pair of matched angles, balanced laminates can have many pairs, plus 0 and 90 degrees. A balanced laminate is orthotropic in in-plane behaviour, but anisotropic in flexural behaviour

BAM

Bundesanstalt für Materialforschung und prüfung, Federal Institute for Materials Research and Testing, Germany

BATCH

Materials produced during a unique sequence:

1. Fibre: The amount which is produced by the conversion of a number of precursor tows under standard, controlled, processing-plant conditions in one continuous operation, including any surface treatment and sizing of the fibre
2. Prepreg: A quantity, irrespective of width, that is produced under 'no-change conditions' in one continuous operation of the impregnating plant from one batch of resin mix and one batch of fibre. A batch is expected to conform to a fixed manufacturing process and to have homogeneous properties within prescribed tolerances over its whole width and length. A maximum allowable length for a prepreg batch is sometimes specified
3. Resin: A quantity of resin in either film or liquid form produced from one mix of resins, resin modifiers and curing agents

BERYLLIUM (Be)

Metallic element, melting point 1289°C, density 1850 kg m⁻³. Uses: aerospace structural material, with good dimensional stability and moderately high service temperatures.

BIAS

A type of weave for a fabric, [See: BIAS WEAVE]

BIAS WEAVE

The weft picks cross the warp ends at 45° or 60° instead of the normal 90°.

BIAXIAL WINDING

In filament winding, a type of winding in which the helical band is laid in sequence, side by side, with no crossover of fibres

BIDIRECTIONAL LAMINATE

A reinforced plastic laminate with the fibres oriented in two directions in the plane of the laminate; a cross laminate. [See also: UNIDIRECTIONAL LAMINATE]

BIG FOOT™

Types of mechanical fasteners that provide a larger footprint, i.e. contact area, than conventional types of fasteners; developed by Monogram

BIOMIMETICS

Synthetic materials which function like natural ones, e.g. artificial tendons and Velcro™

BIOPAN

A multi-user exposure facility, designed for exobiology, radiation biology, radiation dosimetry and material science investigations in space; ESA mission

BIPROPELLANT

Rocket fuel consisting of two chemical components which react on contact in the combustion chamber, e.g. mono-methyl-hydrazine (MMH) and nitrogen tetroxide (NTO)

BISFA

International Bureau for Standardisation of Man-made Fibres

BISMALEIMIDE (BMI)

A type of polyimide that cures by an addition rather than a condensation reaction, thus avoiding problems with volatiles, and which is produced by a vinyl-type polymerisation of a polymer terminated with two maleimide groups. It has intermediate temperature capability between epoxy and polyimide (about 200°C)

BLEED

The removal of excess resin from a prepreg during processing, [See also: CONTROLLED BLEED and ZERO-BLEED]

BLEEDER CLOTH

Non-structural, fibre glass cloth placed adjacent to the composite material part to absorb excess resin during cure, and removed from the part after cure

BLIND

Fasteners: Installed from one side of a component only

BLISK

Turbine disk where the blades and hub are formed as a single piece (Integrally-bladed disk).

BLISTER

Delamination in a distinct local area or areas

BLOX

Laser enhanced oxidation test facility at ONERA, France.

BMI

Bismaleimide. [See: BISMALEIMIDE]

BOND LINE

The area between two materials that have been adhesively bonded; includes the layer of adhesive between the adherends

BOND STRENGTH

The amount of adhesion between bonded surfaces; a measure of the stress required to separate a layer of material from the base to which it is bonded. [See also: PEEL STRENGTH]

BONDED JOINT

The general area of contact for a bonded structure. This includes composite to composite and composite to metal adherends and all forms of adhesives including co- and post-cured joints. [See also: ADHEREND, ADHESIVE, CO-CURE, POSTCURE]

BOR-4

A re-entry test vehicle

BORON (B)

Metallic element, melting point 2092°C, density 2340 kg m⁻³. Uses: alloying additions, doping in aluminides to induce ductility. Reinforcing filaments for polymer or metal matrix composites. Mainly within the USA

BORON CARBIDE (B₄C)

Extremely hard ceramic material with a density of 2520 kg m⁻³

BORSIC

Boron filaments for reinforcement made by deposition onto a fine tungsten wire and coated with silicon carbide (SiC)

BPS

Backpack subsystem; part of an extra-vehicular activity space suit

BRAGG GRATING

A diffraction grating constructed by creating a systematic spatial variation of the structure of a material, such as the molecular structure of a crystal or the refractive index of glass, Ref.[4].

BRAIDING

Process: A mechanical weaving of fibres that enables three or more continuous yarns to be progressively crossed in a predetermined pattern and angle to produce a complex network to form a structural shape, such as a tube, square box or U-shaped channel

BRAZING

Joining technique involving the melting of a material with a lower temperature (brazing) placed between parts to be joined. The parent metal(s) remain(s) solid during brazing

BREADBOARD

[See: DEVELOPMENT MODEL]

BREATHING

Porous material, such as fabric or mat, placed inside the vacuum bag to facilitate removal of air, moisture and volatiles during cure

BRIDGING

A build-up of solder or conformal coating between parts, component leads and/or base substrate forming an elevated path

BROOMING

The appearance of the end of a failed composite material where the reinforcing fibres are clearly visible, such that it resembles a brush or broom

BS

British standard, controlled by the British Standards Institute (BSI).

BSI

British Standards Institute, UK

BUCKLING

1 Unstable displacement of a structural part, such as a panel, caused by excessive compression or shear. Micro-buckling of fibres in a composite material can also occur under axial compression

2 Fibre: a failure mechanism which occurs under compressive loads where the reinforcing fibres in a composite are displaced transversely; fibre buckling modes are known as 'extension mode' and 'shear mode'.

BUNDLE

A number of parallel filaments, normally without organic matrix

BUNDLE STRENGTH

Strength obtained from a test on parallel filaments, with or without organic matrix. The bundle test is often used instead of the monofilament test

BURAN

Russian reusable manned spacecraft: resembling the USA STS Space Shuttle Orbiter

BURST PRESSURE

The pressure at which a pressurized system ruptures or collapses, Ref. [5]

BURST STRENGTH

Hydraulic pressure required to burst a vessel of given thickness; commonly used in testing filament-wound composite structures

BVID

Barely visible impact damage

C

C-C

Carbon-carbon. Carbon fibre reinforced, carbon matrix composite

C/SiC

Carbon fibre-reinforced silicon carbide; a ceramic matrix composite (CMC)

C-STAGE

The final stage in the reaction of certain thermosetting resins in which the material is relatively insoluble and infusible; sometimes referred to as resite. The resin in a fully cured thermoset moulding is in this stage. [See also: A-STAGE, B-STAGE]

CABLE

Two or more insulated conductors, solid or stranded, of equal length, contained in a common covering; or two or more insulated conductors, of equal length, twisted or moulded together without common covering; or one insulated conductor with a metallic covering shield or outer conductor (shielded cable or coaxial cable)

CABLED YARN

[Technical textiles] Two or more folded yarns twisted together

CADMIUM (Cd)

Metallic element, melting point 321°C, density 8650 kg m⁻³, Uses: alloying additions, protective coatings: NOT FOR SPACE USE

C/Al

Carbon fibre reinforced aluminium

CAI

Compression after impact

CALIBRATION

The comparison of two instruments or measuring devices, one of which is a standard of known accuracy traceable to national standards, to detect, correlate, report, or eliminate by adjustment any discrepancy in accuracy of the instrument or measuring device being compared with the standard

CANOPY

The fabric portion of a parachute which provides drag, or drag and lift, when inflated

CAPSA

Alenia Spazio ablative TPS design tool computer program

CARBIDE

A binary compound of carbon with an element more electropositive than carbon, (excluding carbon-hydrogen compounds). Compounds often hard and brittle. Uses: external hardening treatment for steels, as hardening agents within alloys; e.g. silicon carbide is a widely used abrasive in particulate form, or as a matrix for ceramic matrix composites. Carbides, important alloying element in steels and superalloys

CARBON (C)

Non-metallic element, melting point $\sim 3550^{\circ}\text{C}$; graphite sublimates at $\sim 3367^{\circ}\text{C}$; density 2200kg m^{-3} . Uses: carbon reinforcement fibres, matrix in C-C composites, silicon, tungsten. [See also: CARBIDE and CARBON FIBRE]

CARBON/EPOXY

A composite material comprising of a carbon fibre reinforcement in an epoxy polymer matrix

CARBON FIBRE

Fibre produced by the pyrolysis of organic precursor fibres, such as rayon, polyacrylonitrile (PAN) and pitch, in an inert environment. The term is often used interchangeably with the term graphite; carbon fibres and graphite fibres do, however, differ. The basic differences lie in the temperature at which the fibres are made and heat-treated, and in the amount of elemental carbon produced. Carbon fibres typically are carbonised in the region of 1315°C and assay at 93 to 95% carbon, while graphite fibres are graphitised at 1900°C to 2480°C and assay at more than 99% elemental carbon

CARBON-CARBON

Carbon fibre-reinforced carbon, produced by resin or pitch pyrolysis of the matrix of a CFRP, or by CVI; infiltration of a fibrous preform. [See: CVI]

CARE

Carbon fibre-reinforced aluminium laminate. [See: FIBRE METAL LAMINATE]

CARINA

Space recovery vehicle, by Alenia Spazio: CAPSULA di RIentro Non Abitata

CARPET PLOT

A design chart showing the uniaxial stiffness or strength as a function of arbitrary ratios of 0° , 90° and $\pm 45^{\circ}$ plies; used for determination of moduli, strength or thermal expansion coefficients

CARTEC-FT

Study for an Italian scientific payload carrier for re-entry experiments

CAS

Calcium aluminosilicate: a glass-ceramic matrix

CASA

Construcciones Aeronauticas SA, (E); now EADS CASA

CASE

Case describes the whole structure which is necessary for pressure storage. It consists of the pressure vessel, the joint structure and the interface flange providing the connection to the main structure

CASSINI-HUYGENS

NASA Cassini mission to study Saturn, its rings and moons. The ESA-built Huygens probe is for descent onto Titan, the largest Saturn moon.

CAT

Computer-aided tomography

CATALYST

A substance that changes the rate of a chemical reaction without itself undergoing permanent change in its composition; a substance that markedly speeds up the cure of a compound when added in a quantity small compared with the amounts of primary reactants

CATASTROPHIC HAZARD

A potential risk situation that can result in loss of life, in life-threatening or permanently disabling injury, in occupational illness, loss of an element of an interfacing manned flight system, loss of launch site facilities or long term detrimental environmental effects.

Note: For payloads of the NASA STS or ISS, the applicable definition is: 'A potential risk situation that can result in personnel injury, loss of the NASA orbiter, ground facilities, or STS equipment'; (LASTS 1700.7, paragraph 302), Ref. [5]

CAUL PLATE

Smooth metallic plate that is placed in contact with the laminate or adhesively bonded assembly to ensure uniform pressure and temperature during cure and a smooth finish afterwards

CBEN

Cantilever beam enclosed notch; a test method used for Mode II fracture toughness

C-C

Carbon-carbon composite material

CCB

Configuration Control Board

CCD

Charge-coupled Device

CCDTV

Charged-couple device television

CCSiC

Carbon-carbon-silicon carbide composite material

CDA

Copper Development Association

CDR

Critical Design Review

CDS

Characteristic damage state

CEN

Comité Européen de Normalisation (European Committee for Standardization)

CERAMIC

Chemical compound or mixture of compounds with high temperature capabilities, often metal (or silicon) oxides, nitrides or carbides

CERAMIC MATRIX COMPOSITE (CMC)

Composite material in which the matrix is a ceramic

CETEX

Ceramic Tile Experiment (on EXPRESS)

CFD

Computational Fluid Dynamics

CFRP

Carbon fibre-reinforced plastic. Letter G in this handbook stands for Glass, whereas in American publications it is used for graphite. [See also: GFRP]

CFRTP

Carbon fibre-reinforced thermoplastic

CHA

Ceramic Heatshield Assembly

CHAR YIELD

The amount of material remaining after ignition and burning

CHARACTERISTIC DAMAGE STATE (CDS)

A characteristic level at which the amount of cracking induced in a laminate by cyclic loading stabilises

CHEMICAL VAPOUR DEPOSITION (CVD)

Processing method involving the decomposition of a pre-cursor gas rich in the elements required under controlled temperatures and pressures (in a reaction vessel) and deposition onto a component or onto reinforcement fibres. Applicable to metals and ceramic (most common). Uses: coatings and thin section carbon or ceramic matrix composites. Deposition rates are slow, unless substrates are heated (pyrolysis) or laser heat sources (photolysis) are used

CHEMICAL VAPOUR INFILTRATION (CVI)

Same principle as CVD. Term often used to describe the Near-net shape processing method for matrix deposition within fibre preforms. Deposition rates are slow. Proper infiltration of thicker section composites can require thermal gradients or forced flow techniques. Uses: ceramic and carbon matrix composites

[See also: NEAR-NET SHAPE]

CHROMIA

Chromium Oxide (Cr_2O_3)

CHROMIUM (Cr)

Metallic element, melting point $\sim 1863^\circ\text{C}$, density 7180 kg.m^{-3} , Uses: Addition for corrosion (oxidation) resistance in superalloys, steels, coating systems

CI

Configuration Item Number (as per project definition)

CIRCUIT

In filament winding: (1) One complete traverse of the fibre-feed mechanism of a winding machine. (2) One complete traverse of a winding band from one arbitrary point along the winding path to another point on a plane through the starting point and perpendicular to the axis

CIRCUMFERENTIAL ('CIRC') WINDING

In filament-wound reinforced plastics, a winding with the filaments essentially perpendicular to the axis

CLEANROOM

A room in which the concentration of airborne particles is controlled, and which is constructed and used in a manner to minimize the introduction, generation, and retention of particles inside the room, and in which other relevant parameters, e.g. temperature, humidity, pressure; are controlled as necessary, [BS EN ISO 14644-1:1999 3.1.3], Ref. [8]

CLOTH

A manufactured assembly of fibres or yarns with sufficient mechanical strength to hold the assembly together when handled; a fabric more than 150 mm wide. [See also: FABRIC]

CLRD

Common large reflector dish

CLS

Cracked lap shear; a test method used for mixed fracture toughness modes I and II

CMBR

Cosmic microwave background radiation

CMC

Ceramic matrix composite

CME

See: COEFFICIENT OF MOISTURE EXPANSION

CMR

Creep mismatch ratio. In a composite material, the ratio of the creep rate of the fibres to that of the matrix

CN

Centre notch; a test method used for fracture toughness mode I

CNC

Computer numerical control

COATING

1 A material applied to protect a substrate material or assembly, Ref. [10], e.g. against corrosion, oxidation or diffusion

COBALT (Co)

Metallic element, melting point 1495°C, density 8900 kg.m⁻³, Uses: base element for some superalloys, binder for cemented carbides (tungsten carbide), alloying addition to other superalloys

CO-CURE

Simultaneous curing and bonding of a composite laminate to another material or parts, such as honeycomb core or stiffeners, either by using the adhesive properties of the composite resin or by incorporating an adhesive into the composite lay-up

COEFFICIENT OF MOISTURE EXPANSION (CME)

The change in length per unit length produced by the absorption of water (usually by resin matrices or adhesives)

COEFFICIENT OF THERMAL EXPANSION (CTE)

The change in length per unit length produced by a unit rise or decrease in temperature

COHESION

The requirement that the constituent components of the prepreg remain united in the required format for the specified storage and handling conditions. (Specific definition for 'cohesion' in relation to prepreg)

COLLECTED VOLATILE CONDENSABLE MATERIAL (CVCM)

The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific temperature for a specific time, Ref. [8].

Note: CVCM is expressed as a percentage of the initial specimen mass and is calculated from the condensate mass determined from the difference in mass of the collector plate before and after the test

COMBINED TEST

Test imposing the environments in the logical combination, rather than sequentially, to evaluate the synergistic effects between environments, Ref.[1]

COMED

Constellations and multimedia development and demonstration programme; a DLR (D) telecommunications technology demonstration programme completed in 2004

COMET

Commercial Experiment Transporter (NASA) two function recovery capsule. Free-flyer concept of a pressurised recovery system (intended for 227 kg of recoverable experiments) with a non-pressurised, non-recoverable service module

CO-MINGLING

A process whereby thermoplastic fibres are mixed with reinforcing fibres within a yarn

COMPATIBILITY

The ability of two or more substances combined with each other to form a homogeneous composition with useful plastic properties. (Specific definition for 'compatibility' in relation to composites.)

COMPLIANCE

Measurement of softness as opposed to stiffness of a material. It is the reciprocal of Young's modulus, or an inverse of the stiffness matrix

COMPONENT

A device which performs an electronic, electrical or electromechanical function and consists of one or more elements joined together and which cannot normally be disassembled without destruction. The terms component and part can be interchanged. Typical examples of components are transistors, integrated circuits, hybrids, capacitors

COMPOSITE SANDWICH CONSTRUCTION

A panel composed of a lightweight core material, such as honeycomb, foamed plastic, and so forth, to which two relatively thin, dense, high-strength or high-stiffness faces or skins are adhered, Ref. [9]

CONDITION

Metal alloys: a sequence of heat-treatment or mechanical working, which determines the metallurgical structure and hence properties

CONDITIONING

One or more processes applied to samples prior to testing, e.g. to increase or decrease the moisture content, heat treatment, thermal cycling

CONDITION MONITORING

Smart technologies: A diagnostic system which can provide data on the integrity or functioning of machinery, industrial plant or a space subsystem, either continually or periodically

CONDUCTOR

A lead or wire, solid or stranded, or printed-circuit patch serving as an electrical interconnection between terminations

CONFORMAL COATING

Material applied to protect an electronic assembly, Ref. [10]. A thin protective coating which conforms to the configuration of the covered assembly

CONSOLIDATED DECLARED LIST

A prime contractor task which consists of:

- sorting by part, material or process group and merging the items from subcontractors' lists into one project list
- summing up in one item, identical items from different subcontractors,
- negotiating the reduction to one or a few items, where identical functions are performed by an excessive number of parts, [See also: DML, DMPL, DPL]

CONSOLIDATION

A stage in the manufacturing process used to create a composite from either fibres and matrix phases or pre-prepared plies, e.g. thin metal foils, metallised reinforcement fibres or prepreps. Often requires heating and pressure to achieve proper consolidation. Processes can be repeated

CONSTITUENT MATERIALS

Individual materials that make up the composite material; e.g. carbon and epoxy are the constituent materials of a carbon/epoxy composite material

CONTAINMENT

A technique that, if a part fails, prevents the propagation of failure effects beyond the container boundaries, Ref. [5]

CONTAMINATION

Particles, liquids, gases, materials and micro-organisms which by their presence can disturb the performance of an item

CONTINUOUS FILAMENT YARN

Yarn formed by twisting two or more continuous filaments into a single continuous strand

CONTINUOUS REINFORCEMENT

Where reinforcement fibres or filaments pass uninterrupted through the composite

CONTROLLED BLEED

Prepreg materials that contain a resin which is formulated to have flow and gelation characteristics such that excess resin is removed in a controlled manner during consolidation and curing of a composite

CONVENTIONAL METALS

Engineering metals and alloys which do not contain deliberate additions of particulate or fibre reinforcements, i.e. are not considered as composites

COPPER (Cu)

Metallic element, melting point 1085°C, density 8960 kg.m⁻³, Uses: high thermal and electrical conductivity applications

CORE

Sandwich panel: a lightweight material in between the face skins, e.g. honeycomb core, foam. Metallic or composite sheet materials are bonded to the core to form a sandwich panel

CORE SPLICE

A joint or the process of joining one type of core to another; usually achieved by adhesive bonding using an adhesive with gap-filling properties

CORNING DC 235 SILICONE

Commercial silicone-based material produced by Corning

CORROSION

A reaction of the engineering material with its environment with a consequent deterioration in properties of the material, Ref. [9]

Note: The reaction can be chemical or electrochemical

COUNT (Fabrics)

Number of warp and fill yarns per unit length; e.g. a fabric count of 24 x 26 in English units means 24 yarns per inch in the warp, and 26 in the fill

COUPLANT

A substance placed between an ultrasonic transducer and the material under test to ensure a good acoustic path

COUPLING

Linking a side effect to a principal effect. Poisson coupling links the lateral contraction to an axial extension. For composite materials, an anisotropic laminate couples the shear to normal components; an unsymmetric laminate couples curvature with extension. These couplings are unique with composites and provide opportunity to perform extraordinary functions

COUPON

A small test specimen, e.g. usually a flat laminate, for evaluation of basic lamina or laminate properties or properties of generic structural features (e.g. bonded or mechanically fastened joints)

CP

Commercial Purity (Metal alloys, notably Titanium)

CPASB

Coarse pointing areal support bracket; part of SILEX

CPM

Coarse pointing mechanism; part of SILEX

CPN

Corps de Propulseurs à Poudre.

CPS

Chestpack subsystem; part of an extra-vehicular activity space suit

CPU

Central Processing Unit

CR

Commissioning Review

CRACK

1 A defect that behaves like a crack that is initiated, for example, during material production, fabrication or testing or developed during the service life of a component. Note: The term 'crack' in this definition includes flaws, inclusions, pores and other similar defects, Ref. [5]; also known as CRACK-LIKE DEFECT

2 Composite: An actual separation of moulding material visible on opposite surfaces of the part and extending through the thickness; a fracture

CRACK ASPECT RATIO

For a part-through crack, the ratio of crack depth, a , to half crack length, c , i.e. a/c , Ref. [5]

CRACK GROWTH

Rate of propagation of a crack through a material due to a static or dynamic applied load

CRACK GROWTH RATE (da/dN , dc/dN , da/dt or dc/dt)

The rate of change of depth a or length c with respect to the number of load cycles N or time t , Ref. [5]

CRACK GROWTH RETARDATION

The reduction of crack-growth rate due to intermittent overloading of the cracked structural member, Ref. [5]

CRACK-LIKE DEFECT

A defect that behaves like a crack, [See: CRACK]

CRAF

Comet rendezvous and flyby

CRAG

Composite Research Advisory Group, UK

CRAZING

Fine discontinuity which can extend in a network on or under the surface of a plastic material

CREEP

The deformation (permanent change in dimensions) of a material (plastic, metal or ceramic) under constant load over a period of time, not including the initial instantaneous elastic deformation. A process which generally becomes significant at elevated temperatures, at room temperature it is sometimes called cold flow

CREVICE CORROSION

A form of galvanic corrosion occurring within a single phase where a gradient environment exists. [See also: GALVANIC CORROSION]

CRITICAL CRACK

The critical crack size (a_c) defined as the crack size at which the structure fails under limit load, calculated for brittle fracture by:

$$a_c = \frac{(K_c)^2}{\Sigma \pi (F_i S_i)^2}$$

where:

K_c = critical stress intensity factor

S_i = limit stresses†

F_i = stress intensity magnification factors†

†: for different load cases

Note: Factors F_i normally depend on the crack size (a), and is accounted for in the calculations, e.g. by use of an iterative method

CRITICAL FLAW

A flaw of sufficient size and shape to cause unstable growth to occur under the specific operating loads and environment

CRITICAL HAZARD

A potential risk situation that can result in, Ref. [5]:

- temporarily disabling but not life-threatening injury, or temporary occupational illness;
- loss of, or major damage to, flight systems, major flight system elements or ground facilities;
- loss of, or major damage to, public or private property; or short-term detrimental environmental effects

CRITICAL MECHANICAL PART

Mechanical part that requires specific attention or control due to fracture mechanics aspects and limited-life aspects, or with which the Contractor has no previous experience, Ref. [6]

CRITICAL PROCESS

A process is declared critical when it is new or nonvalidated for the application in question or has caused problems during previous use that remain unresolved, Ref. [6]

CRITICAL STRAIN

The strain at the yield point

CRITICAL STRESS-INTENSITY FACTOR (FRACTURE TOUGHNESS)

The value of the stress-intensity factor at the tip of a crack at which unstable propagation of the crack occurs. This value is also called the fracture toughness. The parameter K_{IC} is the fracture toughness for plane strain and is an inherent property of the material. For stress conditions other than plane strain, the fracture toughness is denoted K_c . In fracture mechanics analyses, failure is assumed to be imminent when the applied stress-intensity factor is equal to or exceeds its critical value, i.e. the fracture toughness, [See Stress intensity factor (K)], Ref. [5]

CROSS-LINKING

1 Applied to polymer molecules, the setting-up of chemical links between the molecular chains. When extensive, as in most thermosetting resins, cross-linking makes one infusible super-molecule of all the chains

2 The chemical reaction that occurs in thermosetting polymers due to the heat applied during the cure

CROSS-PLY

Composites containing plies of material, normally prepreg, at angles of 0° and 90°

CROSS-PLY LAMINATE

Special laminate that contains only 0° and 90° plies. This bidirectional laminate is orthotropic and has nearly zero Poisson's ratio. The other simple bidirectional laminate is the angle-ply, which possesses one pair of balanced off-axis plies

CRV

- 1 Crew Return Vehicle
- 2 Crew Rescue Vehicle

CRYOFORMING

Forming (shaping) of metal alloys at very low temperatures, e.g. stainless steels

CRYOGENIC

Very low temperature, generally less than 100 K. Typically the temperature ranges at which the principal atmospheric gases liquify, e.g. Nitrogen: -196°C

CRYOMILLING

Mechanical attrition in liquid nitrogen

CRYOTANK

A tank structure containing a liquid or gas (often fuel) at cryogenic temperatures, [See also: LOX and LH]

CRYSTALLINITY (DEGREE OF)

The volume fraction of crystallites within the polymer

C-SAM

C-scan scanning acoustic microscope; an ultrasonic materials evaluation technique

C-SCAN

The area-scanning of a specimen with ultrasonic acoustic waves. A non-destructive testing technique for finding voids, delaminations and defects in fibre distribution, [See also: A-SCAN and B-SCAN]

CSG

Centre Spatial Guyanais

C-SiC

Carbon-silicon carbide composite material

CSLDV

Continuously Scanning Laser Doppler Vibrometer

CSM

Chopped strand matt; a type of multidirectional, short-fibre reinforcement used for industrial materials rather than high-performance aerospace composites

CT

Computer or computerised tomography

CTE

See: COEFFICIENT OF THERMAL EXPANSION

CTE MISMATCH

- 1 The difference in coefficient of thermal expansion between two or more materials within a specified temperature change, e.g. polymers and metals, Ref. [10].
- 2 The difference in coefficient of thermal expansion between a reinforcement and the matrix or a coating and substrate within a specified temperature rise, e.g. carbon fibre (low/zero CTE) and Al alloy (large +ve CTE)

CTP

Cold thermal protection

CTV

Crew Transfer Vehicle

CURE

- 1 To change the properties of a polymer-based material by chemical reaction accomplished by heat or catalyst (or both) and with or without pressure, e.g. resin, adhesive, coating, Ref. [10].
- 2 A chemical reaction during which a liquid resin is transformed to a solid material by the process of cross-linking

CURE CYCLE

- 1 The relationship between time, temperature and pressure required to achieve the required cure and properties of a polymer-based material, e.g. resin, adhesive, coating, Ref. [10].
- 2 The cure cycle can include defined heat-up and cool-down rates, isothermal holds for specified periods and application and removal of negative or positive pressures at defined times or temperatures. The optimum cure cycle is usually specific to a particular type of prepreg, its lay-up and the component and tool design. Small variations in the prepreg (in particular in the resin) can have a dramatic effect on the cure cycle needed to achieve a satisfactory laminate

CURE STRESS

A residual internal stress produced during the curing cycle of a composite structure

CURIE POINT

The temperature at which a material begins to lose its piezoelectric characteristics. Once lost the process is irreversible, though the material can be recoverable by re-poling

CURING AGENT

Hardener, a catalytic or reactive agent added to a resin to cause polymerisation

CURING TEMPERATURE

Temperature at which a cast, moulded or extruded product, a resin-impregnated reinforcement or an adhesive is subjected to curing

CURING TIME

The length of time a part is subjected to heat or pressure, or both, to cure the resin; interval of time between the instant relative movement between the moving parts of a mould ceases and the instant pressure is released. Note: Further cure can take place after removal of the assembly from the conditions of heat or pressure.[See: POST CURE]

CVCM

Collected Volatile Condensable Matter

CVD

Chemical Vapour Deposition

CVI

Chemical Vapour Infiltration

CVI-C/SiC

Carbon-silicon carbide composite material manufactured by MAN Technologie (D), using Chemical Vapour Infiltration process.

CVSR

Comet Nucleus Sample Return mission

CYANATE ESTER

A family of polymer resins, which can contain bisphenol, phenol or novalac within their formulations, that provide a low moisture absorption capability

CYCLE

Processing of composites: The complete, repeating sequence of operations in a process or part of a process. In moulding, the cycle time is the elapsed time between a certain point in one cycle and the same point in the next

CYCLIC LOADING

A fluctuating load (or pressure) characterized by relative degrees of loading and unloading of a structure. Examples are loads due to transient responses, vibroacoustic excitation, flutter and oscillating or reciprocating mechanical equipment, Ref. [5]

D**DADT**

Differential absorption distributed thermometry. A fibre-optic-based temperature-measurement method

DAISY

Deployable antenna integral system; an antenna design from Dornier

DAMAGE

A structural degradation or anomaly caused by service conditions or by abnormal operation, e.g. impact damage caused by dropped tools or other foreign objects

DAMAGE ACCUMULATION

Term used in fatigue testing of MMC and CMC materials where fatigue cracks initiated in the matrix phase propagate and cause debonding at the fibre-to-matrix interface, but do not damage the reinforcement

DAMAGE CRITICAL PARTS

Structural parts or items whose failure, due to the initiation or propagation of flaws or damages can result in loss of the mission or present a catastrophic hazard to personnel

DAMAGE TOLERANCE

The ability of a material, component or structure to retain an acceptable level of structural or environmental resistance properties under the effects of operational conditions, without risk of failing in a catastrophic manner, [See: DAMAGE TOLERANT]

DAMAGE TOLERANCE CONTROL

The application of design methodology, material and processing control, manufacturing technology, and quality assurance procedures to prevent premature structural failure due to the initiation or propagation of flaw or damage during fabrication, testing and service life

DAMAGE TOLERANT

A structure is considered to be damage tolerant if the amount of general degradation and/or the size and distribution of local defects expected during operation do not lead to structural degradation below limit-specified performance, Ref. [5]

DAMPING

The parameter which governs the resonant response of a material, component or structure; expressed quantitatively either as an absolute or a relative energy basis

DAMPING (MECHANICAL)

Mechanical damping gives the amount of energy dissipated as heat during the deformation of a material. Perfectly elastic materials have no mechanical damping

DART

Distributed anti-Stokes ratio thermometry. A fibre optic-based temperature measurement system

DASA

Deutsche Arbeitsschutzausstellung, German aerospace organisation; now Deutsche Aerospace Airbus

DBTT

Ductile-to-brittle transition temperature

DCB

Double cantilever beam; a test method used for fracture toughness Mode I (GIC)

DC-XA

Delta-Clipper Advanced Experimental Vehicle. An unmanned and rocket-powered, prototype vertical take-off and landing (VTOL) reusable launch vehicle developed under NASA's SSTO programme by McDonnell-Douglas

DDA

Discontinuous Deformation Analysis

DEBOND

Area of separation within or between plies in a laminate, or within a bonded joint, caused by contamination, improper adhesion during processing, or damaging interlaminar stresses [See also: DELAMINATION]:

- 1 Adhesive bond: a delamination between the adherends
- 2 Sandwich panel: a delamination that occurs between the core and the face skin; caused by contamination or damage to either the film adhesive used to join the face skin laminate to the core, face laminate itself, bond area of the core or mechanical damage to core cell walls, by crushing or more local damage

DEBOND

General: a defective area of an adhesive bond where the adherends are no longer held together

DEBRIS

Accumulation of man-made waste materials in space, usually resulting from launch, deployment and other spacecraft operations

DEBULK

To reduce laminate thickness by application of pressure. The compaction is achieved by removing trapped air, vapour and volatiles between plies

DEBULKING

Process: to remove large volumes of air from prepreg materials during their lay-up on or into a mould, whereby some uncured plies of prepreg are formed to the mould surface using a vacuum bag, further plies added to the stack after the bag is removed. If necessary, it is repeated several times especially for thick laminates: a means of reducing porosity or voids in thick laminates or shaped details, e.g. corners

DECLARED MATERIAL LIST (DML)

Consolidated list of all materials used in a project, [See: CONSOLIDATED DECLARED LIST]

DECLARED MECHANICAL PART LIST (DMPL)

Consolidated list of all parts used in a project, [See: CONSOLIDATED DECLARED LIST]

DECLARED PROCESS LIST (DPL)

Consolidated list of all processes used in a project except for non-critical processes sufficiently described in the declared materials list,
[See: CONSOLIDATED DECLARED LIST]

DEFECT

A manufacturing anomaly (crack, void, delamination) created by processing, fabrication or assembly procedures. [See also: FLAW]

DEFLECTION

Displacement of a structure such as a beam

DEFORMATION

Changes in size and shape of a body resulting from externally applied loads, temperature change, and moisture absorption. Deformation in size is measured by the normal strain components; that in shape, by shear component

DEGRADATION

The alteration of material properties (e.g. mechanical, thermal or optical) that may result from deviations in manufacturing or from repeated loading and/or environmental exposure, Ref. [10]

DELAMINATION

Physical separation or loss of bond of the layers of material in a laminate; locally or over a wide area

DELTA CLIPPER

McDonald Douglas single-stage-to-orbit (SSTO) spacecraft

DEMONSTRATION

A method of verification which consists of a qualitative determination of the properties of the test article. It is made through observation or actual conduct, which verifies characteristics such as human engineering features, and transportability. Note: Typical verification method of US standard. In the European standard Demonstration is part of Test, Ref.[1]

DENIER

A yarn and filament numbering system in which the yarn number is equal numerically to the weight in grams of 30 000 ft (9144 m) (used for continuous filaments). The lower the denier the finer the yarn

DENSIFICATION

The consolidation phase of a composite manufacturing technique in which pores or cracks are closed either by further infiltration or by the application of pressure at a specified temperature.

DESIGN ALLOWABLE

Material values that are determined from test data at the laminate or lamina level on a probability basis (e.g. 'A' or 'B' values), following ASTM or other test standards accepted by the final customer. [See also: A-BASIS DESIGN ALLOWABLE; B-BASIS DESIGN ALLOWABLE; 'A' VALUE, 'B' VALUE]

DESIGN AND DEVELOPMENT PLAN

This document is the master plan for the project Design and Development activities and gives high-level information on how the system design is to be carried out and which are the major guidelines for the system development, Ref.[1]

DESIGN FEATURE

An element or detail of a specific design that is not considered generically applicable to other structures for the purpose of substantiation (e.g. lugs and major joints). Such a design element or detail is qualified by a combination of test and analysis

DESIGN VALUES/ PROPERTIES

Material, structural-element and structural detail properties that have been determined from test data and chosen to assure a high degree of confidence in the integrity of the completed structure

DETAIL

A non-generic structural element of a more complex structural member (e.g. specific design-configured joints, splices, stringer run-outs, or major access holes)

DEVELOPMENT

Verification phase with the objective to support the design feasibility and select options able to satisfy manufacturing and performance requirements. The data acquired during this phase are also used to establish processes, procedures and test levels to support subsequent design, production, verification, maintenance and check-out activities. In principle, development is not used to achieve the formal verification close-out, Ref.[1]

DEVELOPMENT MODEL

Physical model used in support to the verification program during the development phase, mainly to confirm mathematical models and, in general, necessary in the areas of new design or where substantial redesign is required. Note: Development Model is also called Breadboard, Ref.[1]

DHS

Distributed hydrogen sensing. A fibre-optic-based measurement system

DIAL

Differential absorption LIDAR: two laser frequencies are used, with different absorption characteristics by an atmospheric molecule of interest. The measured absorptions of the two then provide atmospheric chemical composition information

DIAPHRAGM MOULDING

A shaping process technique applied to thermoplastic-based composites

DIELECTRIC

A material in which the electrical conductivity is zero or near zero

DIFFERENTIAL SCANNING CALORIMETRY (DSC)

Measurement of the energy absorbed (endothermic) or produced (exothermic) as a resin system is cured. Also permits detection of loss of solvents and other volatiles. DSC provides a means of assessing the cure characteristics of the supplied prepreg batch. Like HPLC, it is an analytical technique providing data on which to base comparisons. It can provide reaction start temperature, heats of polymerisation, temperature at peak maximum heat of polymerisation and glass transition temperature (T_g) of cure prepreg

DIFFUSION BONDING (DB)

Joining method for metals in which heated components are clamped together (in vacuum) enabling interdiffusion across the bond line. For bonds between components of the same material the resulting joint is metallurgically undetectable

DIFFUSION

Process of atomic movement of one element into another. Rate of diffusion increases with temperature. Generally implies solid-state diffusion, but also encompasses diffusion of gaseous species through solids

DIFFUSION COATING

Additional alloying elements introduced into the surface of a material by a process of material diffusion at high temperature, normally with strong, coherent oxide-forming elements such as chromium or aluminium to increase the corrosion resistance

DIMENSIONAL STABILITY

Zero or nearly zero deformation due to changes in temperature and moisture content:

1 Materials: A property of carbon/resin and aramid/resin composite materials that is exploited in the design of high-accuracy components in space, e.g. antennas or telescopes

2 Structures: Those which have to retain their physical shape and dimensions under the cyclic thermal conditions experienced in orbit, between -150°C and +100°C, typically

DIMPLING

Sandwich panels: the displacement under load of the face skins between the cellular structure of a honeycomb core

DIN

[Deutsches Institut für Normung](#); German national standards organisation

DIRECTIONAL SOLIDIFICATION (DS)

Manufacturing method used to create a directional microstructure in a material, e.g. in superalloy turbine blades where grains are aligned in such a way as to resist the principal loads

DIRECTIONALLY SOLIDIFIED EUTECTIC (DSE)

Eutectic alloy composition which is directionally solidified to achieve the required microstructure; normally superalloys

DISCONTINUOUS REINFORCEMENT

Where the reinforcement phase consists of particles, whiskers or short fibres

DISCREPANCY

A manufacturing anomaly allowed and detected by the planned inspection procedure. It can be created by processing, fabrication or assembly procedures

DISCRETE COMPONENT

Any individually packaged electronic device, either active or passive, e.g. resistors, capacitors, inductors, diodes, transistors

DISLOCATION

An abnormality within a material lattice structure occurring along certain lines in the crystal structure. These take the form of stacking faults in the regular atomic pattern of the crystal. Deformation in metals occurs by the formation and movement of edge or screw dislocations. 'Cold work' - plastic deformation at low temperature - greatly increases the density of dislocations and anchors them to other dislocations, grain boundaries, the surface or other structural features. This pins crystallographic slip planes, so increasing material strength and reducing elongation to failure (work hardening)

DISLOCATION DENSITY

The number of dislocations within a given material volume. [See also: DISLOCATION]

DISPERSION STRENGTHENING

Increase of alloy strength due to a finely dispersed phase created by precipitated alloying constituents. Note: An optimum dispersion size and volume is required to maximise strength; deviation from the prescribed thermal treatment, in service or in manufacture, affects the strength

DISPLACEMENT

Measure of the movement of a point on the surface and in the interior of a body

DISSIMILAR MATERIALS

Materials with widely differing mechanical and physical properties:

- 1 materials which have different galvanic potentials, such that when they are in contact or joined together under particular environment conditions, e.g. moisture, temperature, there is a possibility of galvanic corrosion
- 2 materials which possess different thermal expansion characteristics
- 3 Joints: The coefficient of thermal expansion (CTE) is a critical property of materials to be joined

DLR

[Deutsches Zentrum für Luft- und Raumfahrt](#). German aerospace organisation

DM

Development Model

DMA

Dynamic mechanical analysis, [See: DYNAMIC MECHANICAL ANALYSIS]

DML

Declared Materials List

DMPL

Declared Mechanical Parts List

DoD

Department of Defense, USA

DOME

In a filament winding, the portion of a cylindrical container that forms the integral ends of the container

DOPING

Alternative term for MICRO ALLOYING

DOT

Department of Transportation, USA

DOUBLE CANTILEVER BEAM SPECIMEN

Interlaminar fracture toughness test specimen, frequently used for CFRP materials

DOUBLER

A sheet of material, made of either composite or metal, applied to a composite laminate or metal sheet to locally increase the properties, e.g. Locally built-up reinforcement or repair

DPL

Declared Processes List

DRAFT

The taper or slope of the vertical surfaces of a mould designed to facilitate removal of moulded parts. (Specific definition of 'draft' in relation to moulds.)

DRAFT ANGLE

The angle between the tangent to the surface at that point and the direction of ejection. (Specific definition in relation to moulds)

DRAPE

Ability of woven and non-woven composite materials to conform to a complex curvature surface, e.g. a fabric to a mould

DRD

Document Requirements Definition

DRY LAY-UP

Construction of a laminate by layering pre-impregnated reinforcement (partly cured resin) in a female or male mould, usually followed by bag moulding or autoclave moulding. [See also: PREPREG]

DS

- 1 Directionally Solidified
- 2 Dispersion Strengthened; dispersion of particles in metal alloys

DSC

Differential scanning calorimetry, [See: DIFFERENTIAL SCANNING CALORIMETRY]

DSDCB

Double split double cantilever beam for Mode III

DSE

Directionally solidified eutectic

DSS

1. Distributed strain sensor; A fibre-optic-based strain measurement system
2. Dimensionally stable structure
3. Dimensionally stable structures programme; and ESA programme

DT

Double torsion; a test method used for fracture toughness Mode I

DTA

Differential thermal analysis

DTRC

David Taylor Research Center, USA; a test method

DTS

Distributed temperature sensor or sensing. A fibre optic-based temperature measurement system

DUCTILE-BRITTLE TRANSITION

The temperature at which a metallurgical phase change in a metal alloy occurs and results in a sudden loss of ductility, e.g. tungsten below 400°C

DUCTILITY

A measure of a material's plastic deformation. Often used to indicate maximum deformation prior to fracture

DUPLEX MICROSTRUCTURE

Two distinct phases within a material microstructure

DWELL TIME

Period of time during cure that a laminate is held at elevated temperature prior to application of pressure

DWI

Deviation Work Item

DYNAMIC MECHANICAL ANALYSIS (DMA)

DMA can be used on uncured prepreg and cured laminates to quantify some of their mechanical properties over a range of temperatures. DMA provides a measurement of storage modulus and loss-modulus in a shear or flexural mode. From these it is feasible to judge the cured material for consistency on expected modulus and modulus retention at elevated temperatures. The glass transition temperature (T_g) of cured material can also be determined. [See: LOSS-MODULUS]

DYNAMIC MODULUS

The ratio of stress to strain under vibrator conditions (calculated from data obtained from either free or forced vibration tests, in shear, compression, or elongation). [See also: DMA]

DYNEEMA

A high-performance fibre based on high modulus polyethylene, manufactured by DSM (NL)

E

E-GLASS

A borosilicate glass containing less than 1% alkali (combined sodium and potassium oxides); the type most used for glass fibres for reinforced plastics; suitable for electrical laminates because of its high resistivity

EAP

Electroactive polymer (EAP) actuators are polymer materials or structures that change volume or shape when electric energy is supplied. Used in smart structures

EB

Electron beam; used in processes such as welding metals and curing resins

EBM

End-burning motor

EB-PVD

Electron Beam Physical Vapour Deposition. A method of depositing surface coatings

EBW

Electron Beam Welding

ECLS

Environmental Control and Life Support

ECSS

European Cooperation for Space Standardization. A cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards, [See: ECSS website].

EDM

Electrical discharge machining. Also called: spark eroding

EDGE CLOSE-OUT

[See: EDGE CLOSURE]

EDGE CLOSURE

Sandwich panels: Protects the core from accidental damage, serves as a moisture seal and provides edge reinforcement to enable transfer and distribution of edge attachment loads; also known as 'edge close-out' and 'edge member'

EDGE MEMBER

[See: EDGE CLOSURE]

EDT

Edge delamination tension; a test method for mixed Modes I and II

EEE

Electrical, electronic and electromechanical

EFA

European Fighter Aircraft; standards

EFCB

ESA Fracture Control Board

E-GLASS

Electrical glass; a grade of glass fibre. A borosilicate glass containing less than 1% alkali (combined sodium and potassium oxides); the type most used for glass fibres for reinforced plastics; suitable for electrical laminates because of its high resistivity

EGSE

Electrical Ground Support Equipment

EIT

Electrical Impedance Tomography

ELASTIC MODULUS

Stiffness

ELASTIC RELATION

Fully reversible, single-value, stress-strain relation. Loading and unloading follow the same path; there is no hysteresis, or residual strain. Although non-linear relation is admissible, the relation for composite materials is essentially linear

ELASTIC-PLASTIC FRACTURE MECHANICS (EPFM)

Adaptation of Linear Elastic Fracture Mechanics (LEFM) engineering principle to describe the propagation of a single crack through a material, usually a metal alloy, which assumes that the bulk of the material is behaving elastically, but compensates for plastic behaviour around the crack tip, [See: LEFM]

ELECTRIC POLING

The action of applying a strong electric field to orientate the dipoles within a ferroelectric ceramic as it is cooled through the ferroelectric transformation point. This conditions suitable materials (e.g. PVdF film) to produce piezoelectric effects

ELECTROLYTE

Galvanic corrosion: Any substance that provides an electrically conductive path between two dissimilar materials, e.g. moisture between carbon and aluminium

ELECTRORHEOLOGICAL FLUIDS

A class of fluids, consisting of colloidal dispersions in non-conducting liquids that exhibit a large, reversible change in their rheological behaviour when subjected to an external electric field

ELECTROSTRICTIVE MATERIALS

Solid materials which deform mechanically when subjected to an external electric field

ELECTROSTRICTION

An induced strain deformation that is independent of field polarity. A weaker effect than piezoelectricity. All dielectrics exhibit this behaviour

ELEMENT

- 1 A part of a more complex structural member, e.g. skin, stringers, shear panels, sandwich panels, joints or splices, Ref.[1]
- 2 A composite of subsystems, capable of performing an operational role only in conjunction with other elements, e.g. Space Vehicle, Ground Segment, Space Station Pressurised Module, Ref.[1]

ELONGATION

Deformation caused by stretching; the fractional increase in length of a material stressed in tension. (When expressed as percentage of the original gauge length, it is called percentage elongation)

ELS

End loaded split; a test method

EMA

Electro-mechanical actuator; for X-38 test vehicle

EMAT

Electromagnetic acoustic transducer

EMC

Electromagnetic compatibility

EMF

Electromotive force

EMI

- 1 Electromagnetic interference
- 2 Electro-mechanical impedance

EN