SLOVENSKI STANDARD
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Vesoljska tehnika - Lepilno spajanje za vesoljska in nosilna plovila

Space engineering - Adhesive bonding for spacecraft and launcher applications

Raumfahrtproduktsicherung - Adhäsionskleben für Raumfahrt- und Trägeranwendungen

Assurance produit des projets spatiaux - Utilisations du collage pour les structure satellites et lanceurs

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49.025.50	Lepila	Adhesives
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Space engineering - Adhesive bonding for spacecraft and launcher applications

Assurance produit des projets spatiaux - Utilisations du collage pour les structure satellites et lanceurs

Raumfahrtproduktsicherung - Adhäsionskleben für Raumfahrt- und Trägeranwendungen

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European Foreword

This document (EN 16602-70-16:2021) has been prepared by Technical Committee CEN-CENELEC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16602-70-16:2021) originates from ECSS-Q-ST-70-16C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2022, and conflicting national standards shall be withdrawn at the latest by April 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a standardization request 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 EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Adhesive materials have a wide range of uses within the space domain however they are often qualified as a minor or negligible part of a large subsystem or system. This frequently results in unforeseen effects arising directly from the adhesive selection which impacts either the functionality, integrity or AIT activities. As a consequence whilst the adhesive is often the lowest cost element of the system it frequently has a high cost associated with the necessary recovery and delta qualification activities need to ensure the system level functionality. Both the system level qualification and any recovery actions are further complicated by the intrinsic relationship between the adhesive performance, the adherend and all the processes associated with the manufacture of the adhesive bond.

European space agencies and the space industry at present have a general handbook available for adhesive bonding (ECSS-E-HB-32-21) however there is no fixed scheme detailing the minimum requirements for verification of adhesive bonding process nor validation of an adhesive material.

Standardisation of the verification processes for adhesives and adhesive bonding across the European space industry is allowing a harmonised and consistent approach.

The generic approach facilitates the correct selection of data thus allowing streamlining of the industrial development activities and enabling the validation of adhesives and verification of adhesive bonding process at an early stage of a programmes lifetime.

This standard is further justified because of the high level of non-conformances (NCR) identified across industry due to limited early programmatic qualification programmes related to adhesive bonding and characterisation of adhesive materials.

1
Scope

The scope of the document addresses the generic verification for all types of adhesive bonding for space applications including evaluation phases. This standard covers all aspects of the adhesive bonding lifetime such as assembly, integration and testing, on-ground acceptance testing, storage, transport, pre-launch, launch and in-flight environments.

This standard does not cover requirements for:

- Adhesive bonding used in EEE mounting on printed circuit boards (for this subject see ECSS-Q-ST-70-61)
- Adhesive bonding used in hybrid manufacturing (for this subject see ESCC 2566000)
- Adhesive bonding for cover-glass on solar cell assemblies (for this subject see ECSS-E-ST-20-08)
- Design of adhesive joints (for this subject see ECSS-E-ST-32)
- Long term storage and long term storage sample testing
- Performance of adhesive bonds
- Functional properties of adhesive joints
- Co-curing processes
- Life-time aging prediction, neither on ground (humidity) nor in-orbit (thermal cycling)

This standard may be tailored for the specific characteristics and constrains of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16603-32	ECSS-E-ST-32	Space engineering – Structural general requirements
EN 16602-10	ECSS-Q-ST-10	Space product assurance -Product assurance management
EN 16602-10-09	ECSS-Q-ST-10-09	Space product assurance -Nonconformance control system
EN 16602-20	ECSS-Q-ST-20	Space product assurance -Quality assurance
EN 16602-40	ECSS-Q-ST-40	Space product assurance - Safety
EN 16602-70	ECSS-Q-ST-70	Space product assurance - Materials, mechanical parts and processes
EN 16602-70-02	ECSS-Q-ST-70-02	Space product assurance - Thermal vacuum outgassing test for the screening of space materials
EN 16602-70-09	ECSS-Q-ST-70-09	Space product assurance - Measurements of thermo-optical properties of thermal control materials
EN 16602-70-22	ECSS-Q-ST-70-22	Space product assurance - Control of limited shelf-life materials
EN 16602-70-71	ECSS-Q-ST-70-71	Space product assurance - Materials, processes and their data selection
	ISO 472:2013/ Amd 1:2018	Plastics - Vocabulary - Amendment 1: Additional items
	ISO 3696:1987	Water for analytical laboratory use - Specification and test methods
	ISO 15785:2002	Technical drawings — Symbolic presentation and indication of adhesive, fold and pressed joints

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

a. For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply.

b. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-70 apply, in particular for the following terms:

   1. critical process
   2. critical material
   3. special process
   4. request for approval

c. For the purpose of this Standard, the terms and definitions from ECSS-Q-ST-40 apply, in particular for the following term:

   1. criticality

3.2 Terms specific to the present standard

3.2.1 adherend

body that is, or is intended to be, held to another body

[ISO 472:2013/Amd 1:2018]

3.2.2 adhesion

state in which two surfaces are held together by interfacial forces which can consist of chemical or mechanical or physical interfacial forces

3.2.3 adhesive bond

see “adhesive joint”

NOTE The term “adhesive joint” is commonly used, but for the process the term “bonding”.

3.2.4 adhesive bonding procedure

detailed instructions, equipment and tools needed to perform the adhesive bonding

NOTE Refer to Annex A for the detailed content.

3.2.5 adhesive bonding process

material joining process where an adhesive material is added in order to maintain chemical, mechanical or physical interfacial forces between bonded parts

NOTE The joining mechanism between adhesive and bonded parts, also called "adherend", is adhesion-based. According to ECSS-Q-ST-70, adhesive bonding belongs to category of "special processes".

3.2.6 adhesive joint

joint of two or more parts of similar or different materials made using adhesives

[ISO 15785:2002]

NOTE The term "adhesive bond" is synonymous

3.2.7 adhesive material

substance with the capability of holding two surfaces together by either chemical, physical or mechanical interfacial forces or a combination of them

NOTE The concept of adhesive materials is addressed in ECSS-E-HB-32-21.

3.2.8 ambient exposure in a controlled environment

item is exposed to ambient air with temperature in the range of (22 ± 3) °C, and relative humidity (55 ± 10) %

NOTE 1 Long term exposure to these conditions can cause degradation of the adhesive joint's performance.

NOTE 2 Contributes to "intrinsic ageing" of the joints.

3.2.9 co-curing

earliest stage of the manufacturing process, resulting in a fully integrated component

NOTE 1 The joining mechanism is chemical cross-linking. Both adherends are undergoing chemical reaction.

NOTE 2 This standard does not cover requirements for the verification of co-curing processes.

3.2.10 co-bonding

intermediate stage of a manufacturing process when an uncured part is joined with one or more cured parts, typically with an additional layer of uncured adhesive

NOTE 1 The joining mechanism between the adhesive and the cured part is adhesion. Between the uncured part and uncured adhesive layer chemical cross-linking is taking place.

NOTE 2 Further text refers only to adhesive bonding or co-bonding (uncured adhesive, cured adherend) or to bonding with pressure sensitive tapes (PSAs).

3.2.11 degradation

undesired change of property of interest in a given time interval

3.2.12 hot-wet exposure

exposure where the test item is subjected to synergistic effect of gaseous water phase and temperature

NOTE 1 The test item is exposed to conditions where temperature and water vapour pressure, typically >25 °C and >65 % RH), are higher than in a controlled environment

NOTE 2 Performed in frame of simulation of on-ground environment within adhesive bonding verification test sequence or as part of independent hot-wet testing

NOTE 3 Inspection and verification of the test item before and after hot-wet exposure is non-destructive and does not prevent test item to be submitted for further testing in frame of verification test sequence

NOTE 3 Also known as “humidity exposure”

3.2.13 hot-wet testing

test where the test item is subjected to hot-wet exposure and the effect of hot-wet exposure is verified after hot-wet exposure is performed

NOTE 1 Hot-wet exposure can be performed in combination with other additional stresses, e.g. mechanical, chemical or electrical

NOTE 2 Functional properties of test item can be verified during hot-wet exposure “in-situ” conditions

NOTE 3 In hot-wet testing of the adhesively bonded joints, hot-wet exposure is typically followed by mechanical tests to verify degradation of the joint and reduction factor associated with hot-wet exposure

NOTE 4 Also known as “damp-heat” testing or “humidity testing”

3.2.14 knock-down factor (KDF)

overall factor that is applied to the material property to account for variations in material composition, service environment and structural geometry

NOTE It can consist of several reduction factors.

3.2.15 reduction factor

ratio between mean value of given material property of exposed test item set and of reference (unexposed) test item sets