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Space engineering — Adhesive bonding handbook

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Full document details: PD CEN/TR 17603-32-21:2022

Table of contents

European Foreword **27**

1 Scope **28**

2 References **29**

3 Terms, definitions and abbreviated terms **30**

3.1 Terms from other documents 30

3.2 Terms specific to the present document' 30

3.3 References 48

4 Joining **49**

4.1 Joining methods for space structures 49

4.1.1 General 49

4.1.2 Adhesive bonding 49

4.1.3 Mechanical fastening disadvantages 50

4.2 References 51

4.2.1 General 51

4.2.2 ECSS documents 52

5 Adherends **53**

5.1 Introduction 53

5.1.1 General 53

5.1.2 Polymer composites 54

5.1.3 Metals 54

5.1.4 Ceramics 55

5.2 Advanced composites 56

5.2.1 Polymer-based composites 56

5.2.2 FML - Fibre metal laminates 60

5.2.3 MMC - Metal matrix composites 60

5.3 Metals 61

5.3.1 Structural materials 61

5.3.2 New materials 61

5.4 Higher-temperature applications 62

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

5.4.1 Adherends 62
5.4.2 Adhesives 62
5.4.3 General guidelines 64
5.5 Low-temperature and cryogenic applications 64
5.5.1 Adherends 64
5.5.2 Adhesives 64
5.5.3 General guidelines 65
5.6 Bonds between adherends 65
5.6.1 General 65
5.6.2 Composite-to-composite 65
5.6.3 Composite-to-metal 66
5.6.4 Metal-to-metal 66
5.6.5 Dissimilar materials 66
5.7 References 67
5.7.1 General 67
5.7.2 ECSS documents 68

6 Adhesive characteristics and properties 69

6.1 Introduction 69
6.1.1 General 69
6.1.2 Guidelines 69
6.2 Types of adhesives 70
6.2.1 Formulation 70
6.2.2 Characteristics 70
6.2.3 Mechanical properties 73
6.2.4 Environmental durability 73
6.2.5 Aerospace structural adhesives 74
6.3 Epoxy-based adhesives 74
6.3.1 General 74
6.3.2 Properties 75
6.3.3 Environmental durability 80
6.4 Polyimide-based adhesives 84
6.4.1 General 84
6.4.2 Properties 85
6.5 Bismaleimide-based adhesives 87
6.5.1 General 87
6.5.2 Properties 87
6.6 Silicone-based adhesives 89

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

6.6.1 General 89
6.6.2 Properties 89
6.6.3 Environmental durability 91
6.7 Elastomeric adhesives 92
6.7.1 General 92
6.8 Adhesives used in space 92
6.8.1 Adhesive systems 92
6.9 References 96
6.9.1 General 96
6.9.2 Data sheets 97
6.9.3 Sources 98
6.9.4 ECSS documents 98
6.9.5 Other standards 98

7 Adhesive selection 99
7.1 Introduction 99
7.2 Adhesive selection factors 99
7.2.1 Guidelines 99
7.2.2 Evaluation exercise 99
7.2.3 Trade-off 100
7.3 Post application selection factors 101
7.3.1 Earth environment 101
7.3.2 Space environment 103
7.4 Pre-application selection factors 106
7.4.1 Joint design 106
7.4.2 Adhesive systems 106
7.4.3 Environmental factors 108
7.4.4 Cost factors 108
7.5 Application 109
7.5.1 Method 109
7.5.2 Cure factors 110
7.5.3 Health and safety 111
7.6 Adhesive screening criteria for space 112
7.7 References 113
7.7.1 General 113
7.7.2 ECSS documents 114
7.7.3 Other standards 115

8 Basic joint types 116

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

8.1 Introduction 116
8.2 Bond or mechanically fasten 116
8.2.1 General 116
8.2.2 Adhesive bonding in the space industry 118
8.3 Loading modes 118
8.4 Tensile shear loading 119
8.4.1 General 119
8.4.2 Joint geometry 120
8.4.3 Composite adherends 122
8.5 References 124
8.5.1 General 124
8.5.2 Sources 124
8.5.3 ECSS documents 125

9 Joint selection 126
9.1 Introduction 126
9.2 Joint strength 126
9.2.1 Failure modes 126
9.2.2 Guidelines 130
9.2.3 Joint design 131
9.3 Fatigue resistance 132
9.3.1 General 132
9.3.2 Joint evaluation 132
9.3.3 Factors influencing fatigue resistance 133
9.4 Acoustic fatigue resistance 135
9.4.1 Bonded carbon/epoxy composite joints 135
9.5 References 137
9.5.1 General 137

10 Theory and design practices 138
10.1 Introduction 138
10.1.1 Analysis 138
10.1.2 Factors of safety 138
10.2 Basic theories of bonded joints 138
10.2.1 Shear lag analysis 138
10.2.2 Linear-elastic stress-strain response 139
10.2.3 Non-linear stress-strain response 139
10.3 Environmental factors for bonded joints 144
10.3.1 Effect of temperature and moisture 144

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

10.4 Effect of bonding defects 148
10.4.1 General 148
10.4.2 Description of bonding defects 148
10.4.3 NDT non-destructive techniques 156
10.5 Double lap and double strap joints 158
10.5.1 Stress distribution 158
10.6 Single lap joints 162
10.6.1 General 162
10.6.2 Load path eccentricity 162
10.6.3 Joint efficiencies 162
10.6.4 Adhesive characteristics 165
10.7 Double-sided stepped lap joints 165
10.7.1 Joint strength 165
10.7.2 Adherend stiffness balance 165
10.8 Single-sided stepped lap joints 168
10.8.1 Joint strength 168
10.9 Scarf joints 168
10.9.1 Joint strength 168
10.10 Calculation of bonded joint strength 169
10.11 Analysis of joint configurations 169
10.11.1 Analytical notation 169
10.11.2 Single lap shear joint 170
10.11.3 Double lap shear joint 173
10.11.4 Double-lap shear joint under mechanical and temperature loads 175
10.11.5 Single taper scarf joint 183
10.11.6 Double taper scarf joint 184
10.11.7 Stepped lap joint 185
10.11.8 Analysis of environmental factors 186
10.12 Analytical design tools 187
10.12.1 General 187
10.12.2 Commercial software 187
10.12.3 In-house software 187
10.13 ESAComp® 187
10.13.1 Background 187
10.13.2 Usage and scope 188
10.13.3 Analysis and data 188
10.14 Astrium: Example spreadsheet 191

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

10.14.1 General 191
10.14.2 Usage and scope 191
10.14.3 Analysis and data 191
10.15 ESDU data and software 194
10.15.1 General 194
10.15.2 ESDU 78042: Bonded joints - 1 194
10.15.3 ESDU 79016: Bonded joints – 2 195
10.15.4 ESDU 80011: Bonded joints – 3 196
10.15.5 ESDU 80039: Bonded joints – 4 196
10.15.6 ESDU 81022: Bonded joints – 5 197
10.16 Design chart 198
10.16.1 Aide memoire 198
10.16.2 Joint category 198
10.17 References 201
10.17.1 General 201
10.17.2 ECSS documents 203
10.17.3 Other standards 203

11 Design allowables 204

11.1 Introduction 204
11.2 Single lap joint 205
11.2.1 Static loading 205
11.2.2 Dynamic loading 209
11.3 Double lap joint 211
11.3.1 Static loading 211
11.4 Symmetrical double scarf joint 212
11.4.1 Static loading 212
11.4.2 Dynamic loading 214
11.5 References 216
11.5.1 General 216
11.5.2 ECSS documents 216

12 Surface preparation 217

12.1 Introduction 217
12.1.1 General 217
12.1.2 Standard processes 218
12.1.3 Development processes 219
12.1.4 Process steps 219
12.1.5 Legislation 219

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

12.2 Composites: Thermosetting matrix 219
12.2.1 General 219
12.2.2 Techniques 220
12.2.3 Abrasion 220
12.2.4 Peel ply 222
12.3 Composites: Thermoplastic matrix 222
12.3.1 General 222
12.3.2 Proposed methods 223
12.4 Aluminium alloys 224
12.4.1 Aerospace aluminium alloys 224
12.4.2 MMC and Al-Lithium alloys 224
12.4.3 Optimised Forest Products Laboratory (FPL) etch 225
12.4.4 Phosphoric acid anodising (PAA) 227
12.4.5 Chromic acid anodising (CAA) 227
12.4.6 Boric sulphuric acid anodising (BSAA) 228
12.4.7 Thin film sulphuric acid anodising (TFSAA) 231
12.4.8 Solvent vapour cleaning 231
12.4.9 Development processes 232
12.5 Titanium alloys 233
12.5.1 General 233
12.5.2 Acid or alkali etch 234
12.5.3 Non-chromium proprietary process 235
12.6 References 235
12.6.1 General 235
12.6.2 ECSS documents 237

13 Bonding methods 238

13.1 Introduction 238
13.1.1 Basic methods 238
13.1.2 Adhesives 238
13.1.3 Composite structures 239
13.2 Co-curing 240
13.2.1 Applications 240
13.2.2 Loading 242
13.2.3 Adhesives 242
13.2.4 Tooling 243
13.3 Secondary bonding 243
13.3.1 General 243

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

13.3.2 Adhesives 243
13.3.3 Tooling 244
13.4 Applying adhesives 244
13.4.1 Film adhesives 244
13.4.2 Paste adhesives 245
13.4.3 Manufacturing processes 248
13.5 Manufacturing factors for adhesives 249
13.5.1 General 249
13.5.2 Product-specific factors 249
13.6 Bondline integrity 251
13.6.1 General 251
13.6.2 Manufacturing-related factors 251
13.7 Thermal bonding thermoplastic composites 251
13.7.1 General 251
13.7.2 Direct bonding 252
13.7.3 Thermabond process 252
13.7.4 Welding techniques 253
13.8 Rapid adhesive bonding (RAB) 253
13.8.1 General 253
13.8.2 Applications 253
13.8.3 Materials 253
13.8.4 Process 255
13.8.5 Equipment 255
13.8.6 Carbon fibre reinforced composites 256
13.8.7 Joint strength 257
13.9 References 257
13.9.1 General 257
13.9.2 ECSS documents 257

14 Quality assurance 258

14.1 Introduction 258
14.1.1 Documentation 258
14.1.2 Standards 258
14.1.3 Aerospace applications 258
14.2 Quality system 259
14.2.1 General 259
14.3 Specifications 259
14.3.1 Procurement 259

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

14.3.2 Incoming inspection 260
14.3.3 Design 260
14.3.4 Processes 260
14.3.5 Materials 261
14.3.6 Training personnel 262
14.4 Check lists 262
14.4.1 Material procurement 262
14.4.2 Bonded joints 266
14.5 References 268
14.5.1 General 268
14.5.2 ECSS documents 268

15 Test methods 269
15.1 Introduction 269
15.1.1 Use of test methods 269
15.1.2 Adhesives for space use 269
15.1.3 Characterisation of adhesives 271
15.1.4 Assessment of adhesive bonding process 272
15.1.5 Test methods and standards 273
15.2 Tensile tests for adhesives 274
15.2.1 General 274
15.2.2 Adhesive evaluation 274
15.2.3 Sandwich panels: Flatwise tensile strength 275
15.3 Shear tests for adhesives 275
15.3.1 General 275
15.3.2 Napkin ring 275
15.3.3 Thick adherend single lap 276
15.3.4 Single lap 276
15.3.5 Double lap 278
15.3.6 Cracked lap shear (CLS) 280
15.4 Cleavage of adhesives 281
15.4.1 General 281
15.4.2 Specimen geometry 281
15.4.3 Typical test results 284
15.4.4 Calculation of fracture strength 285
15.4.5 Loading 287
15.5 Bond durability by wedge test 287
15.5.1 General 287

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

15.5.2 Test specimen and configuration....287
15.5.3 Results and analysis....289
15.6 Peel tests....289
15.6.1 General....289
15.6.2 Climbing drum peel test for adhesives....290
15.6.3 T-peel test....291
15.6.4 Floating roller peel....291
15.7 Fatigue resistance....292
15.7.1 Fatigue properties of adhesives....292
15.7.2 Fatigue resistance of bonded joints....293
15.7.3 Acoustic fatigue....295
15.8 Creep resistance....295
15.8.1 Adhesive properties....295
15.8.2 Test methods....296
15.9 Environmental resistance....296
15.9.1 Earth....296
15.9.2 Space....296
15.10 References....297
15.10.1 General....297
15.10.2 ECSS documents....299
15.10.3 Other standards....299

16 Inspection....300

16.1 Introduction....300
16.2 Role of inspection....300
16.2.1 General....300
16.2.2 Quality control and inspection....300
16.2.3 Non-destructive testing....301
16.3 Defects....301
16.3.1 Bonded joints....301
16.3.2 Adhesion....301
16.3.3 Cohesive properties of adhesives....302
16.3.4 Significance of defects....302
16.4 Inspection techniques....304
16.4.1 Commonly-used techniques....304
16.4.2 Developments....305
16.5 Ultrasonic....306
16.5.1 Applications....306

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

16.5.2 Limitations 306
16.5.3 C-scan 306
16.5.4 Leaky Lamb waves (LLW) 307
16.5.5 Acousto-ultrasonic 308
16.6 Radiography 308
16.6.1 Application 308
16.6.2 Limitations 308
16.6.3 X-radiography 309
16.7 Mechanical impedance: Bond testers 309
16.7.1 Application 309
16.7.2 Limitations 309
16.7.3 Principle 309
16.7.4 Fokker bond tester 310
16.7.5 Acoustic flaw detector 310
16.8 Holography 311
16.8.1 Application 311
16.8.2 Limitations 311
16.8.3 Principle 311
16.9 Thermography 311
16.9.1 Application 311
16.9.2 Limitations 311
16.9.3 Principle 312
16.10 Acoustic emission 312
16.10.1 Application 312
16.10.2 Limitations 312
16.10.3 Principle 313
16.11 References 313
16.11.1 General 313
16.11.2 ECSS documents 315

17 Materials for repairs 316

17.1 Introduction 316
17.1.1 General 316
17.1.2 Repair procedures 316
17.1.3 Repair levels 316
17.1.4 Basic features of bonded repairs 317
17.1.5 Objective of repair 317
17.1.6 Materials 317

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

17.1.7 Design....318
17.1.8 Quality assurance....318
17.2 Parent adherends....320
17.2.1 Materials....320
17.2.2 Sandwich structures....320
17.3 Repair patches....320
17.3.1 Materials....320
17.4 Adhesives....321
17.4.1 General....321
17.4.2 Structural....321
17.4.3 Splice....321
17.4.4 Fillers and mastics....322
17.4.5 Potting compounds....322
17.4.6 Properties....322
17.4.7 Repair adhesive selection factors....323
17.5 References....324
17.5.1 General....324
17.5.2 ECSS documents....325

18 Design of repairs....326

18.1 Introduction....326
18.1.1 Basic categories of repair....326
18.1.2 General design concepts....327
18.1.3 Composite repair design concepts....329
18.1.4 Sandwich panels, laminates and sheet metal....330
18.1.5 Cracked metal components....330
18.2 Concepts for laminates....330
18.2.1 General....330
18.2.2 Flush repairs....330
18.2.3 External repairs....331
18.3 Concepts for sandwich panels....331
18.3.1 Repair objectives....331
18.3.2 Field level repairs....332
18.4 Design parameters: Thin skin constructions....334
18.4.1 Design principles....334
18.5 Design parameters: Crack patching metals....336
18.5.1 Principles....336
18.6 References....337

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

18.6.1 General 337
18.6.2 ECSS documents 337

19 Repair techniques 338
19.1 Introduction 338
19.2 Surface preparation 338
19.2.1 General 338
19.2.2 Guidelines 339
19.2.3 Paint removal 340
19.2.4 Composite adherends 340
19.2.5 Metal adherends: Tank processes 341
19.2.6 Metal adherends: Non-tank processes 341
19.2.7 Use of chemical processes 343
19.3 Repair procedures 343
19.3.1 Basic methods 343
19.3.2 Standard procedures 344
19.3.3 Example: Sandwich panel repair 344
19.4 Equipment 347
19.4.1 Tools 347
19.4.2 Process equipment 347
19.4.3 Hot bonding equipment 347
19.4.4 Facilities 347
19.4.5 Selection of equipment 347
19.5 References 348
19.5.1 General 348

20 Test and inspection of repairs 350
20.1 Introduction 350
20.1.1 Testing 350
20.1.2 Inspection 350
20.2 Testing 350
20.2.1 Adhesive acceptance tests 350
20.2.2 Durability of bonded repairs 351
20.3 Inspection 351
20.3.1 General 351
20.3.2 In-service damage 351
20.3.3 Calibration 353
20.3.4 Standards 353
20.3.5 Guidelines on NDT sensitivity 353

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

20.4 Pre-repair inspection 354
20.4.1 Damage assessment 354
20.4.2 Guidelines 355
20.4.3 Selection of NDT technique 355
20.5 Post-repair inspection 356
20.5.1 Repair verification 356
20.5.2 Guidelines 357
20.5.3 Selection of NDT technique 357
20.6 References 358
20.6.1 General 358
20.6.2 ECSS documents 359

21 Case studies on bonded connections 360
21.1 Introduction 360
21.1.1 General 360
21.1.2 Assembly processes 360
21.1.3 Manufacturing processes 360
21.1.4 Case studies 360
21.2 Aluminium alloy end fittings for CFRP tubes 361
21.2.1 Source 361
21.2.2 Application 361
21.2.3 Objective of study 361
21.2.4 Parameters for design 363
21.2.5 Manufacture 366
21.2.6 Inspection 367
21.2.7 Conclusions 367
21.2.8 Comments on case study 367
21.3 LVA launch vehicle attachment ring and CFRP thrust cone 368
21.3.1 Source 368
21.3.2 Application 368
21.3.3 Objective of study 368
21.3.4 Concept 368
21.3.5 Joint design and analysis 368
21.3.6 Manufacture 371
21.3.7 Assembly 371
21.3.8 Inspection 371
21.3.9 Test 372
21.3.10 Conclusions 372

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

21.3.11 Comments on case study 372
21.4 Shuttle pallet satellite (SPAS) primary framework structure 372
21.4.1 Source 372
21.4.2 Application 373
21.4.3 Objective of study 373
21.4.4 Concept 373
21.4.5 Materials 373
21.4.6 General requirements and overall design description 374
21.4.7 Joint design analysis 374
21.4.8 Manufacturing 377
21.4.9 Bonding process 377
21.4.10 Test 377
21.4.11 Inspection 378
21.4.12 Conclusions 378
21.4.13 Comments 378
21.5 MD 11 outboard flap vane 378
21.5.1 Source 378
21.5.2 Application 379
21.5.3 Objective of the study 379
21.5.4 Parameters for design 379
21.5.5 Concept 379
21.5.6 Materials 380
21.5.7 Joint design 381
21.5.8 Manufacturing 383
21.5.9 Test 383
21.5.10 Inspection 384
21.5.11 Conclusions 384
21.5.12 Comments on case study 384
21.6 CFRP-titanium tubular bonded joint 384
21.6.1 Source 384
21.6.2 Application 385
21.6.3 Objective of study 385
21.6.4 Parameters for design 385
21.6.5 Concept 385
21.6.6 Materials 386
21.6.7 Joint design 387
21.6.8 Analysis 387

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

21.6.9 Manufacture 390
21.6.10 Test 391
21.6.11 Inspection 393
21.6.12 Conclusions 393
21.6.13 Comments on case study 393
21.7 Ariane 5 ACY 5400 upper payload extension ring 394
21.7.1 Source 394
21.7.2 Application 394
21.7.3 Objective 394
21.7.4 Concept 395
21.7.5 Joint design and analysis 396
21.7.6 Manufacture 399
21.7.7 Assembly 401
21.7.8 Inspection 401
21.7.9 Test 401
21.7.10 Conclusions 403
21.7.11 Comments on case study 405
21.8 SRM - solid rocket motors: Flexible joints 405
21.8.1 Source 405
21.8.2 Application 405
21.8.3 Objective of study 406
21.8.4 Parameters for design 406
21.8.5 Concept 408
21.8.6 Materials 408
21.8.7 Joint design 409
21.8.8 Analysis 409
21.8.9 Manufacture 410
21.8.10 Test 411
21.8.11 Inspection 412
21.8.12 Comments on case study 412
21.9 References 413
21.9.1 General 413

22 Case studies on bonded structural materials 414

22.1 Introduction 414
22.1.1 General 414
22.1.2 Sandwich structures 414
22.1.3 Metal laminates 415

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

22.2 CFRP central cylinder for satellites 415
22.2.1 Source 415
22.2.2 Application 415
22.2.3 Objective of study 415
22.2.4 Parameters for design 415
22.2.5 Concept 416
22.2.6 Materials 419
22.2.7 Joint design 420
22.2.8 Manufacture 423
22.2.9 Test 424
22.2.10 Inspection 425
22.2.11 Analysis 425
22.2.12 Conclusions 426
22.2.13 Comments on case study 426
22.3 Filament wound thrust cylinder 427
22.3.1 Source 427
22.3.2 Application 427
22.3.3 Objective of study 427
22.3.4 Parameters for design 427
22.3.5 Concept 427
22.3.6 Materials 428
22.3.7 Design 429
22.3.8 Joint design 429
22.3.9 Analysis 430
22.3.10 Manufacture 430
22.3.11 Test 432
22.3.12 Inspection 432
22.3.13 Conclusions 432
22.3.14 Comments on case study 432
22.4 Ariane 4 payload adapter 937B 433
22.4.1 Source 433
22.4.2 Application 433
22.4.3 Objective of study 433
22.4.4 Parameters for design 433
22.4.5 Concept 434
22.4.6 Materials 434
22.4.7 Design 435

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

22.4.8 Joint design 435
22.4.9 Analysis 436
22.4.10 Manufacturing 438
22.4.11 Test 439
22.4.12 Inspection 439
22.4.13 Conclusions 439
22.4.14 Comments on case study 440
22.5 Galileo radiation shielding 440
22.5.1 Source 440
22.5.2 Application 440
22.5.3 Objective of the study 440
22.5.4 Parameters for design 440
22.5.5 Concept 441
22.5.6 Materials 441
22.5.7 Design 443
22.5.8 Analysis 444
22.5.9 Manufacturing 444
22.5.10 Test 445
22.5.11 Inspection 445
22.5.12 Conclusions 445
22.5.13 Comments on case study 445
22.6 References 446
22.6.1 General 446

Figures

Figure 6.3-1 - Epoxy-based Araldite AV 138M adhesive system: Environmental resistance (DCB tests) 82
Figure 6.3-2 - Epoxy-based Araldite AV 138M adhesive system: Environmental resistance (lap shear tests) 83
Figure 6.6-1 - Silicone-based adhesives: Temperature performance 91
Figure 7.2-1 - Adhesive selection factors 100
Figure 7.3-1 – Environment: Elevated temperature response of adhesive lap joints 102
Figure 8.4-1 - Tensile shear: Single lap joint 120
Figure 8.4-2 – Composite adherends: Orientation of surface fibre 123
Figure 9.2-1 – Joint strength: Relationship between peel and shear stresses and their effect on bond strength with increasing adherend thickness 128
Figure 9.2-2 - Joint strength: Use of different bonded joint types 129
Figure 9.3-1 - Fatigue resistance study: Bonded joint configurations 133

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Figure 9.4-1 - Random vibration resistance study: Bonded joint configurations 136
Figure 10.2-1 - Adhesive in non-linear shear: Stress-strain response 140
Figure 10.2-2 - Adhesive in non-linear shear: Models and characteristics 141
Figure 10.2-3 – Bonded joints: Non-uniform stress and strain distribution 142
Figure 10.2-4 – PABST programme: Design overlaps used in skin splices 143
Figure 10.3-1 – Bonded joints: Effect of moisture on stress distributions 145
Figure 10.3-2 – Bonded joints: Influence of moisture absorption and desorption on peak adhesive shear strains 146
Figure 10.3-3 – Bonded joints: Effect of progressive moisture absorption on bond strain ... 147
Figure 10.4-1 - Bonded joints: Examples of acceptable bond flaw sizes 149
Figure 10.4-2 - Bonded joints: Typical quality zoning 150
Figure 10.4-3 – Double overlap bonded joint: Adhesive shear stresses (defect-free) 151
Figure 10.4-4 - Double overlap bonded joint: Adhesive stresses with edge disbond 152
Figure 10.4-5 - Double overlap bonded joint: Adhesive stresses with away from edge disbond 152
Figure 10.4-6 - Double overlap bonded joint: Adhesive stresses with central disbond 153
Figure 10.4-7 - Adhesive bonded joints: Effect of disbond flaws on flexibility 154
Figure 10.4-8 – Adhesive thickness: Variation of peak induced adhesive stress at ends of bonded joint overlap 155
Figure 10.5-1 - Double lap and strap joints: Reducing peel stresses 159
Figure 10.5-2 - Double lap and strap joints: Effect of overlap on maximum adhesive shear strains 160
Figure 10.5-3 - Double lap joints: Design factors 161
Figure 10.6-1 - Joint efficiency for single lap composite joints: Ductile adhesive 163
Figure 10.6-2 - Joint efficiency for single lap composite joints: Brittle adhesive 164
Figure 10.7-1 - Double-sided stepped lap joints: Adherend stiffness balance 166
Figure 10.7-2 - Double-sided stepped lap joints: Design optimisation 167
Figure 10.11-1 - Analysis: Notation for symmetrical single-lap shear joint 170
Figure 10.11-2 - Analysis: Notation for single-lap joint R-degree peeling 171
Figure 10.11-3 - θ degree peeling strength 172
Figure 10.11-4 - Analysis: Notation for double-lap shear joint 173
Figure 10.11-5 - Analysis: Notation for double lap joint (standard overlap length) 175
Figure 10.11-6 - Shear stress distribution versus the adhesive length for single lap joint without eccentricity 175
Figure 10.11-7 - Stress concentration factor as a function of correlation factor with stiffness ratio parameter 177
Figure 10.11-8 - Shear stress distribution for large overlap lengths 179
Figure 10.11-9 - Stress concentration factor for large overlap lengths 180
Figure 10.11-10 – UD CFRP-HT: Shear stress distribution versus the normalised bond length 181

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Figure 10.11-11 – Quasi-isotropic CFRP-HT: Shear stress distribution versus the normalised bond length 182
Figure 10.11-12 - Analysis: Notation for single taper scarf joint 183
Figure 10.11-13 - Analysis: Notation for symmetrical double tapered scarf joint 184
Figure 10.11-14 - Analysis: Notation for stepped lap joint (recessed and simple) 185
Figure 10.11-15 - Analysis: Notation for recessed and simple scarf joints (four or more steps) 186
Figure 10.13-1 – ESAComp: Double lap joint - example of stresses in the adhesive layer (non-linear adhesive model) 189
Figure 10.13-2 – ESAComp: Double lap joint - example of stresses in the adhesive layer (linear adhesive model) 190
Figure 10.14-1 – Astrium example spread-sheet: Fatigue data, determined by analysis 192
Figure 10.14-2 – Astrium example spread-sheet: Joint design (new) 193
Figure 10.16-1 – Design chart: Aide memoire ‘factors to consider’ 199
Figure 10.16-2 – Design chart: Example of joint category procedure 200
Figure 11.2-1 - Design curve: Static loaded single lap joint with CFRP/epoxy adherends 205
Figure 11.2-2 - Design curve: Static loaded single lap joint with CFRP/epoxy-to-steel adherends 206
Figure 11.2-3 - Design curve: Static loaded single lap joint with CFRP/epoxy-to-steel adherends 207
Figure 11.2-4 - Design curve: Static loaded single lap joint - joint strength versus overlap length for CFRP/epoxy and CFRP/epoxy-to-steel adherends 207
Figure 11.2-5 - Design curve: Static loaded single lap joint - joint strength versus overlap length for CFRP/epoxy adherends 208
Figure 11.2-6 - Design curve: Static compression loaded single lap joint (stabilised sandwich, lower bond) - joint strength versus overlap length for CFRP/epoxy adherends 208
Figure 11.2-7 - Design curve: Single lap joint - tension fatigue S-N curve at RT for CFRP/epoxy adherends 209
Figure 11.2-8 - Design curve: Single lap joint - tension fatigue S-N curve at 180 °C for CFRP/epoxy adherends 210
Figure 11.3-1 - Design curve: Static loaded double lap joint for CFRP/epoxy to titanium adherends 211
Figure 11.4-1 - Design curve: Static loaded double scarf joint for CFRP/epoxy to titanium adherends 212
Figure 11.4-2 - Design curve: Static loaded double scarf joint for CFRP/epoxy to titanium adherends 213
Figure 11.4-3 - Design curve: Double scarf joint tension fatigue S-N curve for CFRP/epoxy to titanium adherends 214
Figure 11.4-4 - Design curve: Double scarf joint tension fatigue S-N curve for CFRP/epoxy to titanium adherends 215
Figure 11.4-5 - Design curve: Double scarf joint tension fatigue S-N curve for CFRP/epoxy to titanium adherends 215

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Figure 12.2-1 - Thermosetting matrix composites: An abrasion surface preparation method 221
Figure 12.2-2 - Thermosetting matrix composites: A simple abrasion surface preparation method 221
Figure 12.4-1 - Aluminium alloy surface preparation: FPL etch process 226
Figure 12.4-2 - Aluminium alloy surface preparation: Phosphoric acid anodise (PAA) process 227
Figure 12.4-3 - Aluminium alloy surface preparation: Chromic acid anodise (CAA) process 228
Figure 12.4-4 - Aluminium alloy surface preparation: Boric/sulphuric acid anodise (BSAA) process 230
Figure 12.4-5 - Aluminium honeycomb preparation: Solvent vapour cleaning 231
Figure 12.4-6 – Surface preparation: Processes applied to aluminium alloys within the aerospace sector 232
Figure 12.5-1 - Titanium alloy surface preparation: Etching 234
Figure 12.5-2 - Titanium alloy surface preparation: Pasa Jell 107C® 235
Figure 13.2-1 - Diagram of co-curing joints for composites: With and without an adhesive layer 241
Figure 13.2-2 - Reticulating film adhesive during cure 243
Figure 13.4-1 - Hand operated applicator for one-part paste adhesives 246
Figure 13.4-2 - Hand operated proportioning machine for two-part paste adhesives 247
Figure 13.4-3 - Typical application route for film and paste adhesives 248
Figure 13.8-1 - Rapid adhesive bonding (RAB) equipment 256
Figure 15.2-1 - ASTM D-897: Metal test specimen 275
Figure 15.3-1 - ASTM D-0229: Napkin ring shear test 276
Figure 15.3-2 - ASTM D-1002: Single lap test specimen 277
Figure 15.3-3 - ASTM D-3165: Single lap test specimen 278
Figure 15.3-4 - ASTM D-3528: Double lap test specimen 279
Figure 15.3-5 - Cracked lap shear (CLS) test specimen 280
Figure 15.4-1 - ASTM D-3433: Cleavage - flat adherend specimen 282
Figure 15.4-2 - ASTM D-3433: Cleavage – CDCB contoured double cantilever beam specimen 283
Figure 15.4-3 - ASTM D-3433: Flat adherend test result chart 284
Figure 15.4-4 - ASTM D-3433: Contoured double cantilever beam test result chart 285
Figure 15.5-1 - ASTM D-3762: Wedge test specimen 288
Figure 15.6-1 - ASTM D1781 climbing drum peel test 290
Figure 15.6-2 - ASTM D-1876 T-peel test specimen 291
Figure 15.6-3 - ASTM D-3167 floating roller peel test 292
Figure 15.7-1 - Examples of fatigue test specimens 294
Figure 16.3-1 - Maximum permissible local defect 303

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

Figure 18.3-1 - Sandwich panel repair concepts 332
Figure 18.3-2 - Field level sandwich panel repair concepts 333
Figure 18.4-1 - Design parameters: Thin skin constructions 335
Figure 19.2-1 - Surface preparation for repairs to aluminium alloys: PANTA process 341
Figure 19.2-2 - Surface preparation for repairs to aluminium alloys: PACS process equipment set-up 342
Figure 19.3-1 – Example: Sandwich panel repair procedure 345
Figure 20.3-1 - Example of NDT Instrument sensitivity: Bonded metal constructions 354
Figure 21.2-1 - Case study: CFRP tube/Al alloy - Joint design for tubular specimens and end fittings 364
Figure 21.2-2 - Case study: CFRP tube/Al alloy - Bonding procedure for end fittings 366
Figure 21.3-1 - Case study: LVA ring/CFRP thrust cone - Basic construction of thrust cone assembly 369
Figure 21.3-2 - Case study: LVA ring/CFRP thrust cone - Joint configurations for LVA ring to thrust cone connection 370
Figure 21.4-1 - Case study: SPAS-01 primary structure 374
Figure 21.4-2 - Case study: SPAS - details of joint dimensions 376
Figure 21.5-1 - Case study: MD 11 outboard flap vane - basic structure 380
Figure 21.5-2 - Case study: MD 11 outboard flap vane - skin lay-up and jointsc 381
Figure 21.5-3 - Case study: MD 11 outboard flap vane - ribs 382
Figure 21.5-4 - Case study: MD 11 outboard flap vane - splice joint analysis 382
Figure 21.6-1 - Case study: CFRP Tube/titanium fitting - bonded joint section 385
Figure 21.6-2 - Case study: CFRP tube/titanium fitting - tensile stress distribution in adhesive layer 388
Figure 21.6-3 - Case study: CFRP tube/titanium fitting - tensile stress distribution in composite 389
Figure 21.6-4 - Case study: CFRP tube/titanium fitting - peel stress distribution in adhesive layer and composite external ply 389
Figure 21.6-5 - Case study: CFRP/titanium end-fitting - analytical notation 390
Figure 21.6-6 - Case study: CFRP/titanium end-fitting - manufacturing procedure 391
Figure 21.6-7 - Case study: CFRP/titanium end fitting - bonded joint failure mechanism 393
Figure 21.7-1 – Case study: Ariane 5 ACY 5400 - location 395
Figure 21.7-2 – Case study: Ariane 5 ACY 5400 - concept 395
Figure 21.7-3 – Case study: Ariane 5 ACY 5400 - sectional view of bonded joint 397
Figure 21.7-4 – Case study: Ariane 5 ACY 5400 - effect of bondline thickness 398
Figure 21.7-5 – Case study: Ariane 5 ACY 5400 - example of (half) FE model for joint 399
Figure 21.7-6 – Case study: Ariane 5 ACY 5400 - witness sample under test 402
Figure 21.8-1 – Case study: SRM – position of fflexible joints 406
Figure 21.8-2 – Case study: SRM flexible joints – example design approach 407
Figure 21.8-3 – Case study: SRM – example of flexible joint concept 408

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Figure 21.8-4 – Case study: SRM – example of flexible joint design....409
Figure 22.2-1 - Case study: CFRP central cylinder - structural elements....418
Figure 22.2-2 - Case study: CFRP Central cylinder - lower ring joint....420
Figure 22.2-3 - Case study: CFRP central cylinder - edge inserts....421
Figure 22.2-4 - Case study: CFRP central cylinder - tank interface inserts....422
Figure 22.2-5 - Case study: CFRP central cylinder - shear panel interface cleats....423
Figure 22.3-1 - Case study: Filament wound thrust cylinder - joint design: Tank interface and end ring....430
Figure 22.3-2 - Case study: Filament wound thrust cylinder - manufacturing sequence....431
Figure 22.4-1 - Case study: Ariane 4 payload adapter - overall view of adapter 937B....434
Figure 22.4-2 - Case study: Ariane 4 payload adapter - end ring joint....436
Figure 22.5-1 - Case study: Galileo radiation shielding - laminate design....444

Tables

Table 4.1-1 - Adhesively bonded aerospace structures: Examples....50
Table 5.2-1 - Polymer-based composite adherends....58
Table 5.2-2 - Metal matrix composite adherends under evaluation....60
Table 5.3-1 - Metal adherends: Currently used or undergoing evaluation....61
Table 5.4-1 - Adhesive bonding of materials: High temperature performance....63
Table 6.2-1 - Classification of adhesives: General characteristics and properties....71
Table 6.2-2 - Classification of adhesives: Typical shear and peel strength characteristics....73
Table 6.3-1 - Epoxy-based film adhesives: Properties....76
Table 6.3-2 - Epoxy-based paste and liquid adhesives: Properties....79
Table 6.3-3 - Epoxy-based adhesives: Environmental durability assessment....80
Table 6.3-4 - Epoxy-based film adhesives: Cytec FM 300-2M and FM 96-U: CTE and shear modulus, determined by TGA and DMA....84
Table 6.4-1 - Polyimide-based film adhesives: Properties....86
Table 6.5-1 - Bismaleimide-based film adhesives: Properties....88
Table 6.6-1 - Silicone-based paste and liquid adhesives: Properties....90
Table 6.8-1 – Adhesive systems used in space: Examples....93
Table 7.3-1 - Adhesives: Typical maximum use temperatures....104
Table 7.5-1 - Typical cure schedules for aerospace structural adhesives....110
Table 7.6-1 - Adhesive selection criteria: Based on bulk property testing....113
Table 8.2-1 - Comparison of joining methods: Fastening and bonding....117
Table 8.3-1 - Basic loading modes in adhesive bonds....119
Table 8.4-1 - Types and geometry for adhesive bonded joints....121
Table 8.4-2 – Composite adherends: Typical transverse (90°) tensile strengths for some aerospace carbon-reinforced UD products....124

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Table 9.3-1 - Fatigue resistance study: Factors relating to resistance of adhesively bonded joints 134
Table 10.4-1 - Bonded joints: Description of NDT methods 157
Table 10.4-2 - Bonded joints: Detection methods for various defects 158
Table 10.15-1 - ESDU data items for bonded joints 194
Table 11.1-1 – Design curves: Summary of bonded joint configurations 204
Table 12.3-1 - Surface Preparation: Proposed methods for thermoplastic composites 223
Table 12.4-1 - Al-Li alloys and SiC particle MMC: Evaluation of surface preparation methods 225
Table 12.4-2 – Surface preparation: Development processes 233
Table 13.1-1 - Comparison between co-curing and secondary bonding as an assembly technique for composite structures 239
Table 13.2-1 - Co-curing methods for composites: With and without an adhesive layer 241
Table 13.5-1 - Manufacturing factors for adhesives 250
Table 13.7-1 - Thermoplastic matrix composites: Welding techniques 252
Table 13.8-1 - Rapid adhesive bonding (RAB): Adherends 254
Table 13.8-2 - Rapid adhesive bonding (RAB): Adhesives 254
Table 14.4-1– Procurement check-list: Paste adhesives – summary 264
Table 14.4-2 – Procurement check-list: Film adhesives – summary 265
Table 14.4-3 – Check list: Adhesive bonding 267
Table 15.1-1 - Adhesive screening: Example of US federal specifications 271
Table 15.1-2 – Test methods and standards: Summary 273
Table 15.9-1- Environmental durability in space: Standard test methods 297
Table 16.4-1 - NDT Techniques: Summary of defect detection capability 305
Table 17.1-1 - Bonded repairs: Examples of applications and materials 319
Table 17.4-1 - Repair adhesives types: Grouped by cure and service temperatures 323
Table 18.1-1 - Basic design concepts for repairs 328
Table 18.3-1 - Field level sandwich panel repairs: Comparison of design concepts 334
Table 18.5-1 - Design parameters: Crack patching metal components 336
Table 19.2-1 - Bonded repairs: Surface preparation 339
Table 19.3-1 - Basic methods for bonded repairs 344
Table 19.4-1 - Use of equipment for bonded repairs 348
Table 20.4-1 - Pre-repair defect inspection methods 356
Table 20.5-1 - Post-repair defect inspection methods 358
Table 21.2-1 - Case study: CFRP tube/Al alloy - Material selection concept design study 362
Table 21.2-2 - Case study: CFRP tube/Al alloy - Material selection detail design study 365
Table 21.4-1 - Case study: SPAS - Material selection/design study for SPAS-01 framework 373

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

Table 21.5-1 - Case study: MD 11 outboard flap vane - materials 380
Table 21.6-1 - Case study: CFRP tube/titanium fitting - material properties 386
Table 21.6-2 - Case study: CFRP/titanium end-fitting - stiffness analysis results 390
Table 21.7-1 – Case study: Ariane 5 ACY 5400 - potential adhesives 400
Table 21.7-2 – Case study: Ariane 5 - typical static load case 403
Table 21.7-3 - Case study: Ariane 5 ACY 5400 - comparison between bonded and riveted assembly 404
Table 22.2-1 - Case study: CFRP central cylinder - trade-off between design concepts 417
Table 22.2-2 - Case study: CFRP central cylinder - structural analysis stiffness results 425
Table 22.2-3 - Case study: CFRP central cylinder - mass analysis 426
Table 22.3-1 - Case study: Filament wound thrust cylinder - design parameters 427
Table 22.3-2 - Case study: Filament wound thrust cylinder - materials 428
Table 22.4-1 - Case study: Ariane 4 payload adapter - materials 435
Table 22.4-2 - Case study: Ariane 4 payload adapter - margin of safety for failure mode analysis 437
Table 22.4-3 - Case study: Ariane 4 payload adapter - manufacturing development summary 438
Table 22.5-1 - Case study: Galileo radiation shielding - estimated radiation levels 440
Table 22.5-2 - Case study: Galileo radiation shielding - design criteria 441
Table 22.5-3 - Case study: Galileo radiation shielding - concepts 441
Table 22.5-4 - Case study: Galileo radiation shielding - materials 442
Table 22.5-5 - Case study: Galileo radiation shielding - properties for Al-Ta-Al bonded joints 443

Documents
Document Sharing Hub
Full document details: PD CEN/TR 17603-32-21:2022

European Foreword

This document (CEN/TR 17603-32-21:2022) 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 17603-32-21:2022) originates from ECSS-E-HB-32-21A.

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

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).

Documents
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1
Scope

This handbook is an acceptable way of meeting the requirements of adhesive materials in bonded joints of ECSS-E-ST-32.

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

2 References

Due to the structure of the document, each clause includes at its end the references called in it.

Documents
Document Sharing Hub

Full document details: PD CEN/TR 17603-32-21:2022

3 Terms, definitions and abbreviated terms

3.1 Terms from other documents

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

3.2 Terms specific to the present document’

The terms specificly used in this document are highlighted as **bold** in the text.

A

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%.

Accelerated ageing test

Short-term test designed to simulate the effects of longer-term service conditions.

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

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

Activators

Chemicals which can be applied directly to a surface or substrate, or mixed with an adhesive to speed up the reaction

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Adherend

A component held to another component by an adhesive

Adherend failure

Failure of a joint in the body of the adherend

Adhesion

The state in which two surfaces are held together by interfacial forces which may consist of both valence forces and interlocking action

Adhesive

A substance with the capability of holding two surfaces together by either chemical or mechanical interfacial forces or a combination of both

Adhesive failure

Failure of an adhesive bond, such that separation occurs at the adhesive/adherend interface

Adhesive strength

The strength with which two surfaces are held together by an adhesive, also known as the bond strength. Quantitative tests are available for measuring the adhesive strength under various environmental and loading conditions

Adsorption

The action of a body in condensing and holding gases and other materials at its surface

AE

See: Acoustic emission

AECMA

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

Ageing

A progressive change in the chemical and physical properties of a material

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]

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

Amorphous

Non-crystalline. Most plastics are amorphous at processing and service temperatures

Anaerobic adhesive

An adhesive which only cures when oxygen (air) is excluded

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Anisotropic

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

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

Autoclave

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

B

B-stage

(1) An intermediate stage in the reaction of certain thermosetting resins 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 premix is usually in this stage. [See also: A-stage, C-stage]

(2) An intermediate stage in the reaction of certain thermosetting polymers wherein the material can still be softened when heated or swelled in contact with certain liquids but cannot be completely fused or dissolved; B-staged resins generally permit some degree of formability or shaping into certain specific configurations

'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 are completely removed during lay-up and are usually coloured to aid this.

Balanced laminate

Lay-up where the ply sequence is symmetrical about the mid-plane

Base monomer

Organic compounds used as the basis for resin formulations

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)

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BMI

Bismaleimide

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.

Bond strength

The degree 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.

Bonding

The joining of adherends using an adhesive

Bond line

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

Bondline thickness

The thickness of the adhesive layer between adherends

Butt joint

Joint in which the plane of the bond is at right angles to a major axis of the adherends

C

C-stage

(1) 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.

(2) The final stage in the cure reaction of certain thermosetting polymers wherein the material becomes largely insoluble and infusible. Attainment of the C-stage completes the cure of these products and generally provides their optimum strength and performance characteristics

Calorie

The quantity of heat required to raise 1 gram of water by 1 °C

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

CARE

Carbon fibre-reinforced aluminium laminate. [See: Fibre metal laminate]

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CAS number

Chemical Abstracts Service. An assigned registry number to identify a material

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

CDCB

Contoured double-cantilever beam

Centipoise (CPS)

A measure of viscosity

CFRP

Carbon fibre-reinforced plastic. G in this handbook (i.e. GFRP) stands for Glass, whereas in American publications it is used for graphite.

Clamping force

The total force exerted by a clamping device on a glue line

Cleavage (of a joint)

The separation of adherends by tensile stresses concentrated at one edge of the bond, such as that caused by a wedge being driven between them

Closed cell foam

Where the porosity cells are not connected to other adjacent cells

CMC

Ceramic matrix composite

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 absortion 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. May differ for different temperature ranges and be highly anisotropic in composite materials

Cohesion

The molecular attraction which holds the body of an adhesive together. The internal strength of an adhesive

Cohesive failure

Failure within the body of the adhesive (i.e. not at the interface)

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Compressive strength

A measure of the material's resistance to compressive loading

Condensation reaction

The combination of two or more molecules resulting in the production of water (or other small, volatile) molecules

Contact adhesive

One which is applied to both substrates, that dries to the touch but will instantly bond when the two surfaces are brought into contact

Core

Sandwich panel: a lighweight 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

Creep

The time-dependent increase in strain resulting from a sustained load

Crevice corrosion

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

Crosslinking

The formation of chemical bonds between adjacent molecular chains resulting in a three dimensional polymer network

Cryogenic

Very low temperature conditions, usually referring to temperatures below 100°K

Crystallinity

A state of molecular structure in some polymers denoting uniformity, compactness and possible alignment of molecular chains

Cure temperature

The temperature to which an adhesively bonded assembly is exposed in order to produce curing of the adhesive

Cure time

The time required to attain full curing of an adhesive

Cure

Changing the physical properties of a material by chemical reaction through condensation or addition polymerization or by crosslinking (e.g. vulcanization). Usually accomplished by the action of heat and catalysts, alone or in combination, with or without pressure. Also referred to as hardening or setting

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Cyanate ester

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

Cyanoacrylate adhesive

A group of acrylic adhesives which cure rapidly through a reaction with trace moisture in the atmosphere or on the surface to be bonded

D

DCB

Double cantilever beam; a test method used for fracture toughness Mode I (G_{IC})

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

Delamination

The separation of the layers within a laminate

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]

DMA

Dynamic mechanical analysis

Double lap joint

Joint made by placing one or two adherends partly over one or two other adherends and bonding together the overlapped portions

DSC - Differential scanning calorimetry

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 (Tg) of cure prepreg

Durability

The endurance of the adhesive joint performance relative to the required service conditions

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Durometer hardness

A measure of the hardness of a material as measured by a durometer. The resultant numerical rating of hardness gives lower numbers for softer materials and higher numbers for harder ones

E

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'

Elasticity

The ability of a material to return to its original shape after removal of a load

Elastomer

A rubbery material which returns to approximately its original dimensions in a short time after a relatively large amount of deformation

Elongation

The fractional change in length of a stressed material

Encapsulate

The process to surround and enclose an object in adhesive. Often used in the electronic industry to protect sensitive components [See also: Potting]

Environment

External, non-accidental conditions (excluding mechanical loading), separately or in combination, that can be expected in service life and that can affect the structure, e.g. temperature, moisture, UV radiation and fuel

Epoxy

A versatile group of thermosetting polymers for adhesive, sealant, coating, potting, encapsulation, impregnation and coating uses. Can be one or two component, room- or elevated-temperature curing. Feature high physical strengths, superior resistance to chemical and/or environmental damage and excellent dimensional stability. Widely employed in structural applications and as electrical insulation materials. Special formulations are available which feature high electrical and/or thermal conductivity. Very wide service temperature ranges are available

ESA

European space agency

ESACOMP

A software package for the analysis and design of composite laminates and laminated structural elements; developed for ESA/ESTEC by Helsinki University and distributed by Componeering Inc

Exotherm

Exothermic reactions produce heat during cure. When large quantities cure at one time, the heat given off (the exotherm) can be enough to melt plastic containers or produce ignition

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Extenders

Ingredients, possibly having some adhesive properties, added to an adhesive composition in order to reduce the amount of the primary adhesive component required per unit of bond area

F

Face sheet

A composite laminate or metal sheet that forms the external surfaces of a sandwich panel

Fatigue failure

Failure of a material due to rapid cyclic stressing

Fatigue life

Number of cycles necessary to bring an adhesive bond to the point of failure when the bond is subjected to repeated cyclic stressing under specified conditions

Fatigue strength

Highest cyclic stress level that will not produce fatigue failure

Fibre metal laminate (FML)

Sheet or laminated material consisting of thin sheets of metal adhesively bonded with layers of fibre-reinforced polymer plies; often with various fibre directions. [See also: ARALL, GLARE and CARE]

Filament winding

Automated process of placing filaments or fibres onto a mandrel in prescribed patterns. The resin impregnation can be before or during the winding, known as prepreg or wet winding, respectively. The mandrel can subsequently be removed after curing of the composite material. Filament winding is most advantageous in building pressure vessels, pipes, drive shafts, or any device that is axisymmetrical

Fillers

Non-adhesive substances added to an adhesive composition to improve ease of application and/or specific properties such as strength, durability, hardness, dimensional stability

Fillet

Adhesive outside the bondline which fills the angle formed where two adherends meet

Film adhesive

A synthetic resin adhesive, usually of the thermosetting type in the form of a thin film of resin with or without a fibrous carrier or support. Note: Film adhesives usually have some tack to enable their placement during assembly

FE

Finite element

FEA

Finite element analysis

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Flash point

The lowest temperature at which the vapours given off by a substance can be ignited

Flow

Movement of an adhesive compound during the application and bonding processes, prior to the onset of cure

Foamed adhesive

An adhesive, the apparent density of which has been decreased substantially by the presence of numerous dispersed gaseous pores. Also known as a cellular adhesive

FPF

First ply failure

FRP

Fibre reinforced plastics

G

Galvanic corrosion

Corrosion that occurs in aqueous or humid conditions that is driven by electrochemical potential differences between two phases, usually metallic, in electrical contact. It can also occur for a single phase where a gradient environment exists; called crevice corrosion. [See: Crevice corrosion]

Gap filling

Ability of an adhesive to effectively fill a wide or variable bondline

Gel time

The time (in minutes) required for a specific quantity of mixed resin and hardener to become unworkable (gelled)

Gel

A semi-solid system consisting of a network of solid aggregates in which liquid is held

GFRP

Glass-fibre reinforced plastic
Note: In this handbook G = glass, but in US publications G = graphite. [See also: CFRP]

GLARE

Glass fibre-reinforced aluminium laminate. [See: Fibre metal laminate]

Glass transition

A reversible change in an amorphous polymer or in amorphous regions of a partially crystalline polymer from (or to) a viscous or rubbery condition to (or from) a hard and relatively brittle one. Glass transition temperature: Tg

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H

Hardener

A substance or mixture of substances added to an adhesive composition to promote the curing reaction; hardeners become part of the cured adhesive compound [See also: Catalyst]

Honeycomb

Manufactured product of resin-impregnated sheet material (paper, glass or aramid-based fabric) or sheet metal formed into hexagonal-shaped cells; used as a core material in sandwich construction

Hot Press

A press designed for laminating in which the lay-up is placed between heated platens

Hot Strength

Strength measured at elevated temperature

Hygroscopic

Tending to absorb moisture from the air

Hygrotherma

The combination of moisture and temperature

I

Impact resistance

A measure of the ability of a material to withstand very rapid loading

Impact strength

The ability of a material to withstand a shock load

Inhibitor

A substance which is added to slow down the rate of a chemical reaction. Can be useful in prolonging the storage or working life of certain types of adhesive

Insert

A fixation device or type of fastener system, commonly used in sandwich panels

IR

Infra red

IR pyrometer

A device designed to measure surface temperature using Infrared emissions

J

Joint

(1) General: Any element that connects other structural elements and transfers loads from one to the other across a connection, Ref. [[3-1]].

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(2) Bonded: The location at which two adherends are held together with a layer of adhesive; the general area of contact for a bonded structure. Common bonded types are:

- Butt Joint: The edge faces of the two adherends are at right angles to the other faces of the adherends.
- Scarf Joint: A joint made by cutting away similar angular segments of two adherends and bonding them with the cut areas fitted together.
- Lap Joint: A joint made by placing one adherend partly over another and bonding together the overlapped portions

Joint area

The region where two or more adherends are held together with layers of adhesive

K

Kpsi

Thousands of pounds per square inch

L

Laminate

Plate consisting of layers of uni- or multidirectional plies of one or more composite materials

Lap joint

Joining or fusing of two overlapping surfaces

Lap shear

Shear stress acting on an overlapping joint

M

Mechanical adhesion

Adhesion between surfaces in which the adhesive holds the parts together by interlocking action

MMC

Metal matrix composite

Modifier

Any chemically inert ingredient added to an adhesive formulation that changes its properties

Modulus of elasticity

The ratio of stress to related strain as determined in tension (Young's Modulus), compression, shear or flexure

Molecular weight

The sum of the atomic weights of all atoms in a molecule

MSDS

Material Safety Data Sheet

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N

Non volatile content

The portion of material remaining once the volatile material has been driven off, e.g. solvent content of some adhesives

O

Offgassing

(1) General: Depending on the application, there are restrictions on the gaseous products released from materials or finished articles in operational vacuum conditions that can:

- contaminate other equipment, [See also: OUTGASSING]
- contaminate the air during preparatory or operational conditions for manned spacecraft.

(2) The evolution of gaseous products for an assembled article subjected to slight radiant heat in the specified test atmosphere, [Ref. [3-2]]. Note: It applies to materials and assembled articles to be used in a manned space vehicle crew compartment

Open time (Open assembly time)

Period during which the adhesive remains active without curing after being applied to the substrate

Outgassing

(1) General: Depending on the application, there are restrictions on the gaseous products released from materials or finished articles in operational vacuum conditions that can:

- contaminate other equipment (outgassing)
- contaminate the air during preparatory or operational conditions for manned spacecraft, [See: OFFGASSING]

(2) Release of gaseous species from a specimen under high vacuum conditions, Ref. [[3-3]]

P

Paste

An adhesive composition having a thickened consistency to avoid slumping

PEEK

Polyether ether ketone

Peel

Mode of application of force to a joint where one or both of the adherends is flexible and in which the stress is concentrated at a joint boundary

Peel ply

A layer of resin free material used to protect a laminate and be subsequently removed for secondary bonding

Peel strength

(1) An adhesive's resistance to be stripped from a bonded joint, usually with the stripping force applied at a predetermined angle and rate.

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(2) The average load per unit width of a joint tested under peel loading

Peel test

A test of an adhesive using one rigid and one flexible substrate. The flexible material is usually folded back (usually 180°) and the substrates are peeled apart. Strength is usually stated in units of N/cm.

PEI

Polyether imide

Phenolic resin

Thermosetting resin for elevated temperature use produced by the condensation of an aromatic alcohol with an -aldehyde, particularly of phenol with formaldehyde

PI

Polyimide

Plasticity

A property whereby material can be deformed continuously and permanently, without rupture, upon the application of a stress that exceeds the yield stress

Plasticizer

Ingredients incorporated into an adhesive composition that enhance flow, deformation and flexibility; the addition of plasticizers also tends to reduce tensile strength properties and elastic moduli while increasing toughness and impact strength

Polyamide

A polymer in which the structural units are linked by amide or thio-amide grouping; many polyamides are fibre-forming

Polyester

Thermosetting resins produced by dissolving unsaturated, generally linear alkyd resins in a vinyl active monomer, e.g. styrene, methyl styrene, or diallyl phthalate

Polyimide

A polymer produced by reacting an aromatic dianhydride with an aromatic diamine; used for the matrix phase of composites; highly heat-resistant resin above 315°C typically

Polymer

A complex, high molecular weight, compound made up by the reactive linking of simple molecules. The growing polymer chains have functional groups that can be linked by addition or condensation reactions

Polymerization

Chemical reaction in which one or more small molecules combine to form larger molecules

Porosity

A condition of trapped pockets of air, gas or vacuum within a solid material.

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Post cure

A treatment usually involving the application of heat to an adhesive assembly following initial cure. Its purpose is to modify certain properties, such as heat resistance, chemical inertness

Pot life

The length of time a liquid or paste adhesive remains usable after it has been mixed with a catalyst and hardener

Potting

The process of filling a cavity or space with an adhesive compound. Often used for the fixing of insert into sandwich panels and for the protection of electronic assemblies

Pre treatment

Mechanical and/or chemical processes to make an adherend more suitable for bonding

Press time

The period required for a joint to be held under pressure during cure

Primer

A coating applied to an adherend surface prior to the application of the adhesive in order to enhance the adhesion and therefore the strength of the bond

Proportional limit

The maximum stress a material can withstand without significantly deviating from a linear stress to strain relationship

Psi

Pounds per square inch

Pyrometer

A non-contact device to measure surface temperature

Q

R

REL

Recommended exposure limit

Release sheet

A sheet, serving as protection for an adhesive film, that is easily removed from the film or prior to use

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Resin

A class of solid or semi-solid organic products of natural and synthetic origin, generally of high molecular weights with no definite melting point. Resins are generally water-insoluble and have little or no tendency to crystallize. However, certain resins, such as some polyvinyl alcohols and polyacrylates, are readily dispersible in water. Others, such as polyamides and polyvinylidene chloride, are readily crystallized.

RH

Relative humidity

Rheology

The study of the flow properties of materials, especially of non-newtonian liquids and plastics. Non-newtonian materials are substances where the flow is not proportional to the stress applied

RT

Room temperature

RTV

Room temperature vulcanizing

S

Sandwich

(1) Construction: An assembly 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.

(2) Panel: A sandwich construction of a specified dimensions.

Note: The honeycomb and face skins can be made of composite material or metal alloy.

Scarf joint

A joint made by cutting away similar angular segments, usually at an angle of less than 45°, of two substrates and bonding the substrates with the cut areas fitted together

Sealant

A material which adheres to two adjoining parts of an assembly and prevents the passage of gases, dust, liquids, etc. into or out of the assembly at that point

Shear modulus

The ratio of shear stress to shear strain (below the proportional limit)

Shear strength

In an adhesively bonded joint, this is the maximum average stress parallel to the joint before failure

Shear

The effect of forces acting in opposite but parallel directions

Shelf life

The length of time that a limited-life material (e.g. an adhesive) in its packaging, can be stored before use, under the conditions specified by the manufacturer, without degradation

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Silicone

A family of polymeric products whose molecular backbone is made up of alternating silicon and oxygen atoms and which has pendant hydrocarbon groups attached to the silicon atoms. Used primarily as elastomeric adhesives and sealants, silicone is known for its ability to withstand large variations in temperature. Both one- and two-part silicone systems are available.

Solids content

The percentage by weight of non-volatile material in an adhesive or sealant

Specific gravity

The ratio between the density of a material and that of water

Specific heat

The ratio between the quantity of heat needed to raise the temperature of a material to that of water

Starved joint

A joint with insufficient adhesive to produce a satisfactory bond

Strain

The unit change in shape or size due to stress

Stress-cycles (SN) curve

Diagram showing the relationship between cyclic stress level and number of cycles to failure

Stress-strain diagram

A plot of corresponding values of stress and strain for a material

Structural adhesive

One capable of transferring sustained loads between bonded components

Substrate failure

Failure of a joint through the substrate material. The cohesive strength of the adhesive and the adhesive forces between the adhesive and substrate exceed the internal strength of the material being bonded

Substrate

Material to be adhesively bonded

Surface preparation

Physical and/or chemical pretreatment of a substrate to enhance the adhesive bond strength

T

Tack

The property of an adhesive that enables it to form a bond of measurable strength immediately after adhesive and adherend are brought into contact under low pressure

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Tear strength

The load required to propagate a tear in, for example, a sealant test specimen

Tensile strength (of an adhesive joint)

The maximum tensile stress that a material is capable of sustaining calculated from the maximum load applied perpendicular to the joint divided by the cross sectional area of the joint

Tg

See: Glass transition temperature

TGA

Thermo-gravimetric analysis

Thermoplastic

Polymeric materials which will repeatedly soften and flow as the temperature is increased and harden as the temperature falls

Thermoset

Polymeric materials which only cure when exposed to heat are described as thermoset resins. Subsequent heat exposure has little or no effect on the properties of the cured resin

Thixotrophy

The viscosity of some materials reduces under isothermal agitation and subsequently increases again at rest

TLV

Threshold limit value

U

Ultimate elongation

Elongation at failure

Undercuring

An incorrect process in which there is insufficient time or temperature to enable full and proper curing of an adhesive or resin

UV

Ultra violet

V

Vapour pressure

The pressure exerted by a saturated vapour above its own liquid in a closed container

Viscosity

Measure of fluid thickness or resistance to flow

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Voids

Gas or air pockets trapped within a material

Volatile organic compound (VOC)

Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and excluding any 'exempt compound' that participates in atmospheric photochemical reactions. The VOC is a measured or calculated number which reflects the amount of volatile organic material that is released from a product as it dries.

W

Working life

The period of time during which an film adhesive remains suitable for use. [See also: Pot life for liquid and paste adhesives].

3.3 References

[3-1] ECSS-E-ST-32-01 – Space engineering – Fracture control

[3-2] ECSS-Q-ST-70-29 – Space product assurance – Determination of offgassing products from materials and assembled articles to be used in a manned space vehicle crew compartment

[3-3] ECSS-Q-ST-70-02 – Space product assurance – Thermal vacuum outgassing test for the screening of space materials

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