

Welcome and Introduction

ESA SME Initiative

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SME INITIATIVE COURSE
MATERIALS

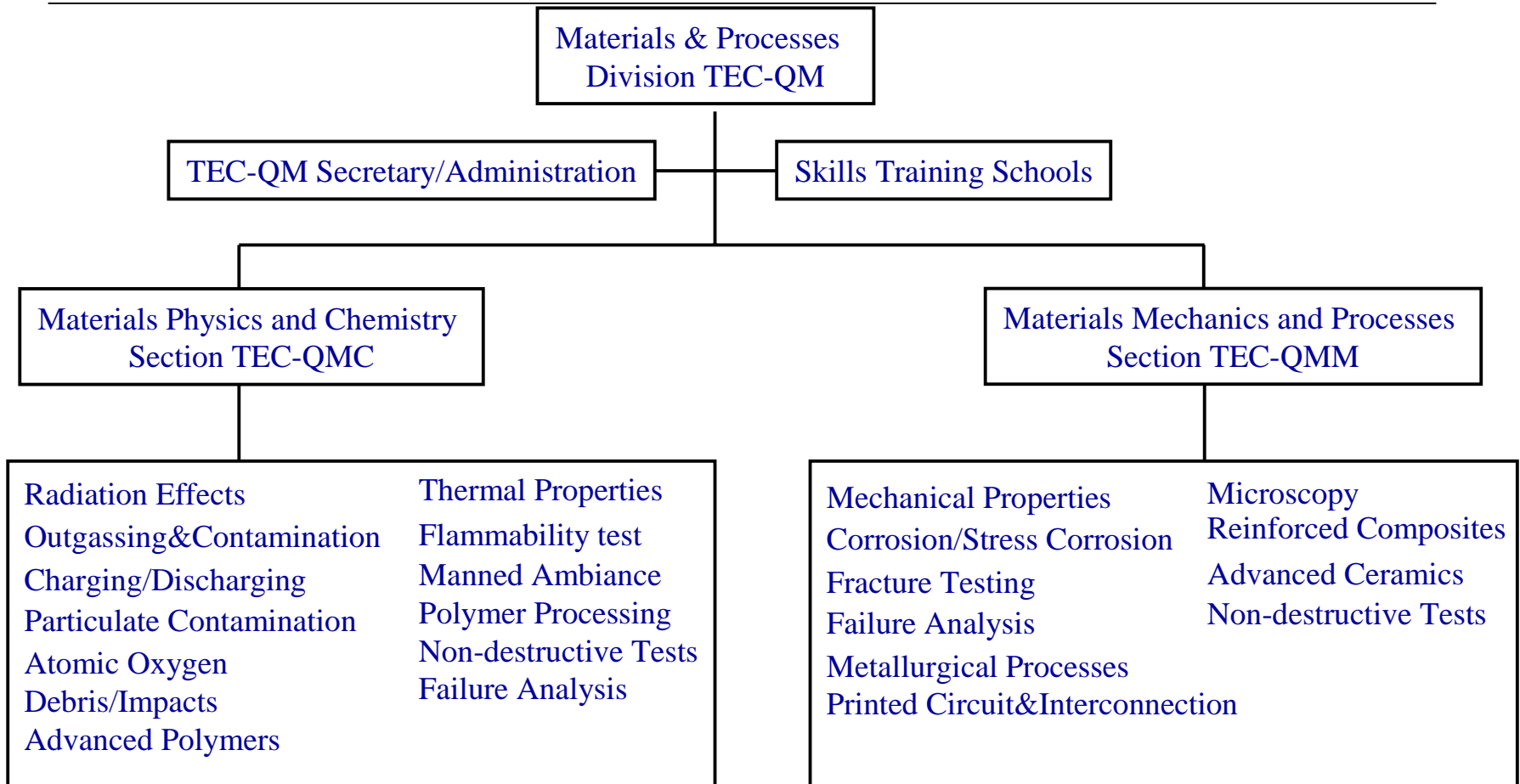
MATERIALS AND PROCESSES DIVISION
ESTEC

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PROJECT REQUIREMENTS, DOCUMENTS
AND DEFINITIONS.

Course Content

1. Welcome and Introduction: *B. D. Dunn*
2. The Spacecraft Environment and Materials Interaction: *M. Van Eesbeek*
3. Materials Properties & Associated Test Methods for Metallic Materials: *A. de Rooij*
4. Materials Properties & Associated Test Methods for Non-metallic Materials: *T. Rohr, C. Semprimoschnig*
5. Composites: *L. Pambaguan, C. Semprimoschnig*
6. Electronic Materials: *C. Villette*
7. Electronic DML/DPL/DMPL: *A. de Rooij*
8. Cleanliness and Contamination Control: *T. Rohr, D. Wernham*
9. Materials and Means of Thermal Control: *Ph. Poinas*
10. Human Spaceflight: *G.C. Bussu, T. Rohr*
11. Practical Demonstrations: *T. Rohr, T. de Rooij, C. Semprimoschnig, D. Wernham*



Introduction

The final choice of materials and processes shall only be made by specialists in the field of space materials, in accordance with the Product Assurance standard ECSS-Q-70 “Requirements for Materials, Mechanical Parts and Processes”

A good starting exercise is to consult the new ECSS standard Q-70-71 “Data for the Selection of Space Materials and Processes” (issued 2004)

One question frequently asked is “Why does ESA not have a preferred materials list whereas such a list does exist for electronic components?”

The reason for this is best summarised by the relationship:

$$\text{Material + Process} \xrightarrow{\text{Environment}} = \text{Application}$$

In other words a material can only be considered together with the associated process and the final application. To complicate matters further the effects of the environment (manned or unmanned, LEO or GEO etc.) have to be considered since these can significantly affect the suitability of the application

Example 1

For example:

Solithane 113 + Process \longrightarrow = PCB Conformal Coating
(Polyurethane) (24 hr 65 °C)

This combination is occasionally used in spacecraft applications.

However, for manned space applications this cannot be used since Solithane, in common with most polyurethanes, is flammable. Also, under severe thermal cycling this product can damage electronic components and soldered joints (as it is a hard coating with a high coefficient of thermal expansion).

Example 2

Sylgard 184 + Process → PCB Conformal Coating
(Silicone) (RT cure)

This combination is used for manned space applications.

However for applications exposed to space vacuum this cannot be used since Sylgard does not meet the outgassing requirements.

Materials are therefore approved in conjunction with the associated process, the application and the associated environment.

In other words, approval is granted **per project**. The Declared Materials List (DML) is used for this ESA (or customer) approval process

Tailoring

The requirements for Materials, Mechanical Parts and Processes (MMPP) that are given in the ECSS Q-70 standard are generally used – however, occasionally they can be tailored. This tailoring will depend on the actual factors relevant to a particular project, e.g.

1. Type of spacecraft (manned or unmanned)
2. Spacecraft orbit (LEO, GEO, polar, etc)
3. Complexity (satellite, payload, etc.)
4. Duration of space exposure (x years, y days, etc.)

The requirements will therefore be specified as part of the contract either in the statement of work (SOW) or in the PA plan

Constraints on materials

- ❑ Temperature
- ❑ Vacuum
- ❑ Thermal cycling, vibration
- ❑ Chemical (corrosion)
- ❑ Galvanic compatibility
- ❑ Atomic oxygen
- ❑ Moisture absorption/desorption
- ❑ Fluid compatibility

Processes

- ❑ Specifications – need for a Process Identification Document (PID)
- ❑ pcb's manufacturing
- ❑ soldering processes
- ❑ crimping
- ❑ wire wrapping
- ❑ Repair and modification of PCB assemblies
- ❑ Cleaning
- ❑ Welding
- ❑ Painting, anodisation, etc