CMT

Price Estimate to Characterize Material for use in the COMPRO Process Model

Introduction

In order to be used effectively, COMPRO requires a substantial amount of input data to describe the time and temperature dependent evolution of material properties. The quality of this material property data is of paramount importance for producing accurate model results. Given its specialized nature, material suppliers typically have not developed, or do not share, the type and quality of data required for COMPRO models. Furthermore, public domain data of this type is limited only to the most widely used material systems, e.g. AS4 / 8552.

For these reasons a COMPRO user may choose to have a material characterized by CMT, specifically for use in the COMPRO process model. This document provides an overview of the procedures followed, and the costs associated with this task. Note that the discussion relates primarily to curing laminate materials such as pre-pregs* and adhesives

Type / Complexity of Model

It is incumbent on the COMPRO user to decide what level of detail and class of problem they wish to focus on. For instance, some users may be mainly interested in reducing their process cycle time, while still ensuring that their parts achieve a full degree of cure. In this case, the characterization required would be limited to that which relates to inputs for the COMPRO Thermochemical Module. Other users may be interested in residual stresses and final part shapes, in which case a more extensive suite of property data must be developed. CMT engineers will work closely with the customer's engineers and R & D staff to determine the appropriate level of characterization.

The range of property data of interest is shown in Table 1. A brief description of the problem classes / complexity and the relevant test procedures is presented in following sections.

Table 1: The spectrum of material property data which a COMPRO user may require.

More Complex →

More Complex ↓

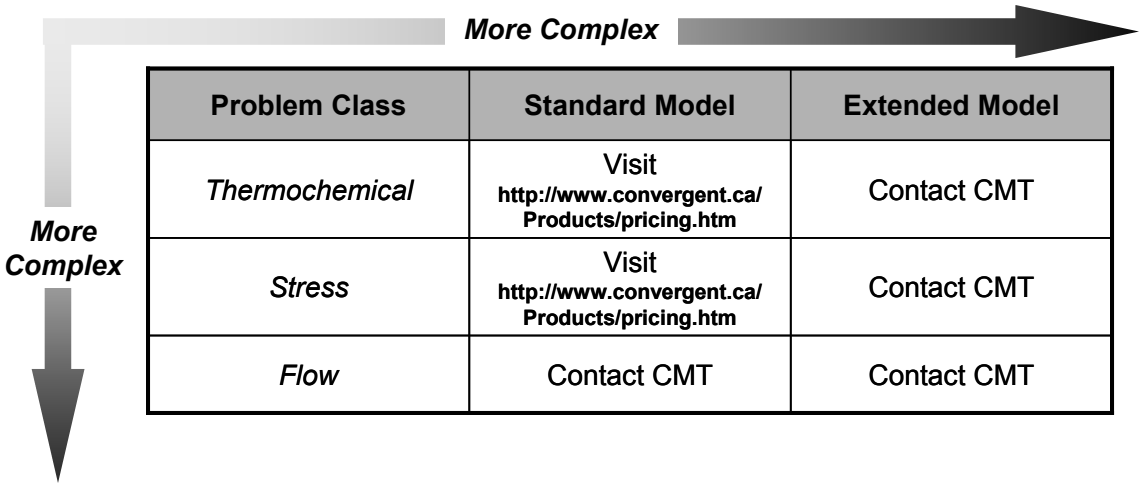
Problem Class	Standard Model	Extended Model
Thermochemical	•Cure Kinetics •Specific Heat	•Thermal Conductivity
Stress	•Modulus Development •Cure Shrinkage •CTE	•Viscoelastic Modulus Development
Flow	•Viscosity	•Fibre Bed Compaction •Fibre Bed Permeability

*CMT does not characterize reinforcing fibers. The properties of most fibres are well documented and this information is typically available from the material vendor.

Convergent Manufacturing Technologies Inc.
2386 East Mall, Suite 101, Vancouver, British Columbia, Canada, V6T 1Z3
Tel: 604-822-9682, Fax: 604-822-9659, inquiries@convergent.ca, www.convergent.ca

Once the user has determined their requirements, CMT will perform (a) the necessary tests and (b) reduce this data to the appropriate equations or look-up tables for use in COMPRO. The reduced data will be in a form suitable for use external to COMPRO as well. The price and timeline associated with characterizing a material to the degree required by the majority of COMPRO users is shown in Table 2.

Table 2: Price (US$) / Time estimate for recommended material characterization



Problem Class	Standard Model	Extended Model
Thermochemical	Visit http://www.convergent.ca/Products/pricing.htm	Contact CMT
Stress	Visit http://www.convergent.ca/Products/pricing.htm	Contact CMT
Flow	Contact CMT	Contact CMT

Thermochemical Problems

If the user is solely interested in thermal management problems (i.e. cure cycle times, degree of cure development) there is no need for material data which supports the COMPRO Stress or Flow Modules. The relevant material properties, namely specific heat capacity and the development of resin degree of cure, are determined through extensive DSC testing.

If COMPRO is going to be used to model particularly thick laminate sections, i.e. > ½", than the user may wish to invest in more extensive characterization of the material thermal conductivity.

Residual Stress / Deformed Shape

For any problems which involve the COMPRO Stress Module, the Thermochemical Module dataset is *pre-requisite*. The Stress Module itself requires a data set which describes the evolution of material modulus, cure shrinkage and Coefficient of Thermal Expansion (CTE) with respect to temperature and degree of cure. This data is determined from DMA and TMA testing. Particularly advanced users of COMPRO may wish to consider viscoelastic effects in which case, a larger range of DMA testing must be performed.

Flow Problems

For any problems which involve the COMPRO Flow Module, the Thermochemical Module dataset is *pre-requisite*. Problems in which resin flow is particularly relevant are those involving bleed material systems or laminates with varying initial local fiber volume fraction. Material viscosity data is determined using a Rheometer. Advanced users may wish to consider the fiber bed properties in their model as well, requiring a number of specialized test procedures.

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Quantity and Type of Material Required

The customer must supply all the material needed for testing purposes. The majority of the tests require only small quantities, hence approximately 1 lb of material should suffice for all of the testing. The material must be supplied in the un-cured state.

Intellectual Property Issues

Any material property data-set which CMT develops specifically for a customer is the property of the customer. This data will not be shared with other COMPRO users, nor published, without the expressed consent of the customer.

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