Accure

Accure Project Outline:

Cure Monitoring for Shorter Cycle Times

A 2½ year project to evaluate the benefits, practicality and comparative performance of a broad range of cure-monitoring techniques

Background

One of the single most important aspects in the manufacture of composites, and in the application of adhesives and organic coatings, is the measurement of the degree of cure of the part. Cure monitoring is important to every thermoset composites and adhesives manufacturer/user, as accurate monitoring of cure provides the opportunity to shorten manufacturing cycle times, improve repeatability and reduce operating costs.

There is a broad range of emerging technologies that have the potential to allow cure to be measured in real-time. To date, there has only been a limited take-up of these techniques due to a lack of knowledge of the different monitoring methods and their operation.

This project will evaluate the benefits, practicality and comparative performance of a broad range of cure-monitoring techniques for adhesives, coating and composites.

Industrial Involvement

The 2½ year project will be commissioned by the DTI as part of their Measurement for Materials Systems programme, starting with a technology review in Spring 2002.

There is an opportunity for companies to address the specific problems associated with cure measurement by becoming part of the project's Industrial Advisory Group (IAG), steering the project direction towards their specific requirements. This group will comprise representatives of a cross section of users and suppliers of composite materials and process equipment, controlling the overall direction of the project to ensure that it meets their objectives and that it delivers cure measurement methods that are of commercial benefit.

Work Programme

The overall project approach is to selectively focus on appropriate cure monitoring techniques, starting with a broad review of available techniques and limitations and ending in detailed evaluation of 2 or 3 selected techniques.

The approach to be taken is to undertake a thorough review of techniques, followed by a sequence of comparative tests resulting in the selection of the 2 or 3 most appropriate techniques for the applications detailed by the Industrial Advisory Group. These techniques then undergo further development and evaluation through more comprehensive testing in the latter stages of the project. The output of each of these areas of work will be combined in the last six months through a programme of dissemination, demonstration and technology transfer.

The outline work programme is detailed below:

Work Package 1: Review of Cure Measurement Techniques
A review of new and existing cure measurement techniques for practical application in coatings application, adhesive bonding and composite component manufacture. Techniques under evaluation will include all major variations of electrical (eg dielectric, capacitance), optical (eg shearography, non-contact Raman) and excitation systems (eg ultrasonic, piezo-electric, vibrating needle).
Deliverable: A comprehensive review report covering the advantages and disadvantages of the full range of existing cure monitoring techniques, and their suitability for coatings application, adhesive bonding and composite component manufacture. This will allow the selection of the 5 leading techniques for practical comparative trials in Work Package 2.

Work Package 2: Evaluation of Selected Measurement Methods
A series of comparative practical trials to provide a realistic assessment of the advantages and limitations of the 5 leading cure monitoring options available, based on the output of Work Package 1. The direction of the work in this phase of the project will be strongly led by the Industrial Advisory Group, who will determine the materials and eventual applications on which the project will concentrate.
Deliverable: This work package will result in a full practical comparison of the applicability of 5 cure measurement techniques to the materials and substrates selected by the Industrial Advisory Group, and will allow the selection of the 2 leading techniques for further development in Work Package 3.

Work Package 3: Development of Leading Techniques
This work package will focus on overcoming the difficulties associated with the existing cure monitoring techniques, enabling them to be more widely and effectively used in industrial applications. At this early stage it is envisaged that the techniques chosen will be the leading methods in each of the 3 main families of methods (electrical, optical and excitation systems).
Deliverable: Developed test methodology and equipment, tested in the controlled conditions of the laboratory, for practical application to the case study materials, processes and applications selected by the Industrial Advisory Group.

Work Package 4: Industrial Evaluation of Developed Measurement Techniques
In parallel with Work Package 3, the developing cure measurement techniques will be continuously evaluated for their sensitivity, robustness and applicability to the industrial applications that they are intended for.
Deliverable: 2 or 3 robust, cost effective measurement methodologies for practical application in harsh industrial environments, for the applications selected by the Industrial Advisory Group.

Work Package 5: Production of a Measurement Guidance Note
This work package will concentrate on the creation of a guidance note on the selection and application of the appropriate cure-monitoring system for a range of applications.
Deliverable: A comprehensive measurement guidance note, giving a simple decision-making route for the selection of the most effective cure-monitoring technique for a wide range of applications. Advantages and disadvantages of each technique will be details, as well as the likely industrial benefits and costs of implementing on-line cure monitoring.

Work Package 6: Effective Dissemination
A combination of dissemination activities will be used to provide broad project results to a large number of companies, and to transfer specific project information to companies eager to use the results in the short term, inside and outside the Industrial Advisory Group. In addition, a detailed project report will be prepared.
Deliverable: Regular formal and informal meetings of the partners; case studies; demonstration facilities; secondment of staff; comprehensive project web site and a series of publications and events.

Work Package 7: Project Management
The management the project will consist of a Project Coordinator at NetComposites, liaising directly with the Project Managers and Cranfield and PRA to form a coordinated team. The Project Coordinator will be responsible for all liaison with the Industrial Advisory Group and DTI, will ensure that the tasks run to cost and timescale, and will coordinate the financial and administrative aspects of the project. The Industrial Advisory Group will be invited to meet with the project team every four months to review progress made and agree in detail the forward direction of the project.

IAG Role and Benefits

Companies involved in this project from an early stage will gain specific insights into the measurement of cure, the results of this project removing many of the perceptions and problems associated with the cure monitoring.

To ensure that the technology is developed efficiently and used quickly, the Industrial Advisory Group will be set up to include representatives from all areas of the supply chain. This will be embodied in a formal partnership of materials and coatings suppliers, equipment suppliers, processors, manufacturers and technology users, and will be added to by informal liaisons with companies outside the formal group. In this way, the supply chain for the industry will be represented, allowing the developed measurement techniques to be widely taken up.

As well as steering the overall direction of the project, the Industrial Advisory Group will also be making specific contributions to the project in terms of cash and in-kind support.

The level of in-kind and cash contributions will reflect the business nature of the partner. In addition to input at the formal and informal meetings, specific input will encompass the supply of equipment, materials and case study components to the work programme. To encompass the breadth of the supply chain and application areas, the Industrial Advisory Group will comprise 10-15 companies, each providing a proportion of the cash and in-kind contributions. The cash contributions will be staged evenly over the life of the project, while the in-kind contributions will increase as the project progresses, being at a peak in the testing phase of the project.

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Timing

The DTI has asked for industrially supported proposals to reach them by 16 November 2001. It is likely that the project will start in Spring 2002 and be completed in Autumn 2004.

Project Team

This project brings together 3 highly complementary organisations to ensure that the project results are both accurate and industrially relevant.

NetComposites
NetComposites will undertake the management of the project, as well as the assessment of excitation based cure monitoring systems and the dissemination aspect of the project. It will also ensure the applicability of the results to the composites industry.
NetComposites is an integrated web and offline business, developing and providing knowledge on composites. A major aspect of this is the development of innovative products and processes and the creation of generic knowledge on composites to accelerate the growth of the industry.

Cranfield University
Cranfield will undertake the majority of the practical work within the project, drawing on their extensive expertise in cure monitoring technologies. They will also ensure the applicability of the results to adhesive cure.
Cranfield holds the expertise and facilities for assessing the primary options for cure monitoring. Historical expertise has been in real-time dielectric cure monitoring and computer modelling of cure kinetics, cure kinetics monitoring using refractive index-based and transmission IR optical fibre sensors and correlations with data from FTIR, DSC, density measurement and viscometry.

Paint Research Association
PRA will provide the interface with the coatings community, ensuring that the project results are applicable to the unique speed and thickness characteristics of reactive coating systems.
PRA is the premier research association in the coatings field and the largest independent coatings centre of its kind. Its technical interests cut across the entire coatings chain - from raw material suppliers and paint manufacturers to applicators and end-users. Wood preservation, printing inks and adhesives also fall under PRA's technical ambit.

Further Information

To find out how to become involved in this project, please contact one of the project team:

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