

COMPUTER INTERACTIVE MATURITY SYSTEMS (CIMS) USING SIMULATION AND MODELING OF POLYMER CURING TECHNOLOGIES

Historically, the exploration and development of new materials (substances) are based on experimental methods, or the trial-and-error methods. In the 1950s, the trend in materials and molecular design was focused on studies of relationships between material structure and material property by quantum chemistry. Later, people adopted more sophisticated methods, such as artificial intelligence, databases and computer information processing to build expert systems. The computer-aided simulation methods have been the main stream in the field of advanced materials design. Some of these expert systems are also used for optimal control in the manufacturing of materials. In addition, as the latest trend in materials research and process control, the so called intelligent processing of materials is now being adopted in the manufacturing of various advanced materials. Today, materials design is not only a hot research topic at institutes and universities, but also a critical focus in industry. A completely new methodology is being proposed in the current research for the development of advanced materials and substances.

However, researchers' experience indicates that about 60% of the engineering materials data are not separable, and these data show no pattern for recognition. The data mining/ knowledge discovery models are proposed to separate such data into subspaces so that a feasible mathematical model in the original parameter space can be obtained. An important step in data mining is the reparability test, whereby a good reparability leads to a feasible model in a subspace and vice versa. Once a data pattern has been recognized, an artificial intelligence and expert system can be applied to find the mathematical models for classification, selection, prediction and discrimination of large data sets and for finding associations among the inconsistent data patterns. The knowledge obtained by the expert system, including the mapping graphics by data mining, criterion equations, trained neural nets and the optimum, is stored in a materials data/knowledge base for later use.

In this research, prototype knowledge discovery techniques are projected to engineering materials design applications and emerged as new knowledge discovery models to alleviate large scale and complex computational efforts associated with simulation and modeling of polymer matrix composites, cure analysis of polymer matrix composites and for developing intelligence

processing and manufacturing materials systems. A number of prototype and workable design examples are discussed to show the efficacy of the proposed systems.

This research has also investigated knowledge discovery models for materials classification and selection, cost effective reinforcement fiber and polymer matrix discovery, high-performance polymer matrix composites prediction, polymer matrix composite structural analysis and mature cure state analysis of polymer matrix composites. All these models are integrated as a novel computational system called Computer Interactive Maturity Systems (CIMS). The major contributions associated to Computer Interactive Maturity Systems (CIMS) are organized as follows.

1. Conceptual Computer Interactive Knowledge Engineering System (CIKES) and Object-Oriented Knowledgebase for Engineering Materials organization is proposed as a novel technology in data mining and knowledge engineering paradigm for providing generalized computational environment with distinct expert systems and for creating materials database and data warehouse systems for organizing materials data and information generated by the earlier computer based expert systems associated to composite materials designs.
2. An expert decision support materials classification and selection systems(MCSS) for materials selection and their performance classification respectively on input design requirements and input specifications of composite component to be designed, has been proposed and implemented. Materials characterization and discrimination tasks are performed on the Materials database. Materials are classified into Polymer, Ceramic and Metal classes. Two novel mathematical models: Exponential Similarity Measure Model and Performance Classification Models have been developed respectively for the selection of material among the materials pruned by the linear decision tree classifier and for their performance classifications.
3. Artificial intelligence classification model with Neural Networks application has been implemented for engineering materials classifications on non linear input design parameters. This model predicts the optimal number of hidden neurons in the multilayer back propagation neural network model for minimizing the classification errors. The results of this

model compared with Gaussian classification model and showed that the classification accuracy 99% with error less than 1%.

4. Cost-effective polymer matrix composite selection model using Data Mining approach has been developed for the selection of candidate polymer matrix and a reinforcement fiber for a design application. This model clusters the possible reinforcement fibers for a target polymer matrix material that optimizes the relative costs of polymer composite materials that meet the design requirements.
5. Cost-effective and high-performance polymer composite prediction model has been developed using statistical correlation analysis model for the selection of a polymer matrix and a reinforcement fiber based on the respective input requirements. Unsupervised learning Self Organization Map (SOM) algorithm has been deployed for clustering the cost effective high performance materials based on their performances indices.
6. Polymer Matrix Composite Performance Analysis Knowledge Engineering Model (PMCPAKEM) for predicting the general characteristics of the structural composites has been developed for engineering the knowledge discovered by the knowledge discovery models. This model predicts the mean stiffness of composite laminate in which reinforcement fibers are placed at different orientations in different layers of composite laminate.
7. Pultrusion technology based maturity curing system with 3-D numerical algorithms/procedures is developed for predicting polymer composite cure status during transmission of heat through the composite.

Under the Guidance of
Dr. S C Sharma,
Professor and Director,
CMRTU, Bangalore-59.

Doreswamy,
Research Scholar,
Department of P.G .Studies and
Research in Computer Science,
Mangalore University,
Mangalagotri-574 199.