Rapid Assessment of Electronic Product Enclosure Plastics for Manufacturing Support and End of Life Management

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The electrical and electronic industry in common with the automotive industry, faces significant materials management challenges that range from the selection and processing of virgin materials to their management when products reached-of-life. This is particularly acute in the electrical and electronic products industry where product life spans range from one year or less to 15 years or more and where the amount of waste product produced each year in the UK exceeds one million tonnes. These high volumes of waste, often containing hazardous substances, illustrate the magnitude of the problem that industry and society face.

Virtually all of the engineering polymers used in today's electrical and electronic products can be recycled. The challenge is making the process of recovery and recycling economical and reliable by providing qualified materials that manufacturers know they can use with confidence. We report first findings from a project funded by IeMRC which has made use of very recent developments in using light, across the whole of the visible spectrum and into the infrared and the ultraviolet regions, to measure the chemical and physical characteristics of engineering thermoplastic materials used in electrical and electronic products such as computers, televisions and mobile phones.

We have explored the use of these new light probing methods to rapidly identify plastic materials used in the enclosures and casings of electrical and electronic products both at the manufacturing stage and when the products reach the end of their useful life. We have scoped out the ability of these methods to undertake rapid (1 to 2 second) screening of materials at the general formulation level using existing equipment designed for insulation materials condition assessment in power transformers. Where property data exists, we have explored statistical models to predict properties, to establish the potential for QA measurements on incoming virgin materials and for qualification for end-of-life sorting and classification. We have also determined the potential to predict the aged condition of materials at end-of-life and after multiple reprocessing operations for various enclosure materials.

We have shown that these spectroscopic techniques linked with multivariate statistical analysis methods can discriminate between many of the materials used in enclosures for sorting purposes. Further, the techniques can be used to provide a measure of "quality" of the materials in addition to a measurement of their properties. This has been done by taking two enclosure polymers and subjecting them to controlled degradation through thermal processing and light (UV) ageing, and showing that these changes can not only be tracked, but used to construct a mathematical model that allows prediction of mechanical and melt flow properties. The techniques can also qualify some additives in these materials including flame retardants used to reduce fire hazards.

Although there are some sensitivity issues with our chosen range of light spectroscopy (visible and near infrared) when applied to very dark objects, the methodology shows that using a combination of colour recognition and molecular spectroscopy can provide rapid access to many polymer characteristics including physical properties, that provide a much finer, more valuable grading and qualification of materials than simple recognition of polymer type and this can be achieved in a simple rapid non-destructive measurement.