Predicting plastics durability

BRANZ has developed a new technique for assessing and predicting the durability of polymers - a useful capability for industry given the widespread use of this material in common building products.

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**POLYMER-BASED MATERIALS** are used in many building products such as wall coverings, spouting, building underlays and flashing tapes.

**Environment affects polymer durability**

The durability of these materials can be significantly affected by environmental conditions, particularly sunlight, UV, temperature and moisture. As discussed in ‘Sun-smart materials’ (Build 142), New Zealand experiences high solar and UV intensities. This means the New Zealand environment is challenging when it comes to durability of plastics and other polymeric materials.

The New Zealand Building Code is unique in that it contains a durability clause (B2) that requires a minimum durability for building materials and components. The minimum requirement depends on the specific application and location of a building element. For example, easily accessed and replaced elements have a not less than 5-year durability requirement, while structural or difficult to replace elements have a not less than 50-year or the life of the building durability requirement.

**Limits with current testing**

Laboratory testing used to assess the durability of building materials was discussed in ‘Accelerated weathering and durability’ (Build 102). This looked at the limitations with both natural weathering and accelerated ageing of building products.

There are also few broadly applicable, reliable, quick, lab assessment methods to predict the durability performance of polymeric materials.

The lack of suitable, timely methods to assess the durability of some materials can be a barrier to market for innovative products.

**New BRANZ assessment method**

BRANZ has recently begun investigating a new approach to assess and predict the durability of plastics - Fourier transform infrared spectroscopy (FTIR).

This is a well established technique that has been widely used for analysing...
Materials performance

Polymeric materials. A more recent development, made possible by advances in computing power, is multi-component analysis, known as chemometrics.

FTIR combined with chemometrics is a useful way to study complex chemical interactions. BRANZ is using them to understand the chemical changes that take place in plastics as a result of degradation due to environmental exposure. This information can be used to develop reliable accelerated test methods to assess and predict the long-term durability of plastics.

**Challenges correlating weathering**

Correlating natural and artificial weathering in a reliable and predictable way has always been the challenge in studies of this kind. Typically, it has been carried out by comparing mechanical properties, such as strength or flexibility, from natural and artificially aged samples.

FTIR provides several advantages over measuring mechanical properties as it:

- directly measures any chemical changes in the sample due to ageing
- can show that the artificial ageing produces the same type of degradation seen as a result of natural weathering
- is non-destructive
- is very quick
- can be used in the field.

**Started with model for polyethylene**

Polyethylene was the first plastic looked at using this approach. This may be exposed to weathering when used in ducting, trims and wood plastic composites.

Figure 1 shows a FTIR spectrum of polyethylene—one for a new sample and another that has been exposed outdoors. There are clear differences between the spectra, and these can be used to understand and predict durability of the material.

Several spectra have been recorded for polyethylene that has been artificially weathered for a range of known time periods. From these, a chemometric model has been built that can be used to predict the equivalent artificial ageing time for any other sample of polyethylene. As a result, we can compare samples of polyethylene that have been exposed to natural weathering and correlate this with artificial weathering time (see Figure 2).

**Extending technique to other materials**

Early results show that FTIR is going to provide a valuable new capability for the BRANZ materials research programme. This technique has been successfully demonstrated to predict durability for polyethylene and is currently being used to develop data for polypropylene and polyvinyl chloride.

Future work will extend the use of this approach to studies of other polymeric materials such as structural adhesives and coatings.