DSC Analysis of Recycled Polyethylene

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Polymer recycling classifies plastics as one of seven codes. Typically because of its speed and ease of use, FTIR with an ATR is used to identify this. However, polyethylene is sorted into grades by its density and FTIR cannot sort these. In addition, small levels of contaminates may be unseen by ATR or the IR's limit of detection.

Differential Scanning Calorimeter (DSC) is a powerful technique for detecting the melting points and crystallinity of polymers. Looking at the melting points of the polymer allows us not only to determine the grade of polyethylene, but we can detect the presence of other polymers like polypropylene (PP), nylons, etc. Equipped with an autosampler, this is a quick method to assure the grade of PE.

1 PETE	2 HDPE	3 PVC	4 LDPE	5 PP	6 PS	7 OTHER
polyethylene terephthalate	high-density polyethylene	polyvinyl chloride	low-density polyethylene	polypropylene	polystyrene	other plastics, including acrylic, polycarbonate, polyactic fibers, nylon, fiberglass
soft drink bottles, mineral water, fruite juice container, cooking oil	milk jugs, cleaning agents, laundry detergents, bleaching agents, shampoo bottles, washing and shower soaps	trays for sweets, fruit, plastic packing (bubble foil) and food foils to wrap the foodstuff	crushed bottles, shopping bags, highly-resistant sacks and most of the wrappings	furniture, consumers, luggage, toys as well as bumpers, lining and external borders of the cars	toys, hard packing, refrigerator trays, cosmetic bags, costume jewellery, CD cases, vending cups	

Results
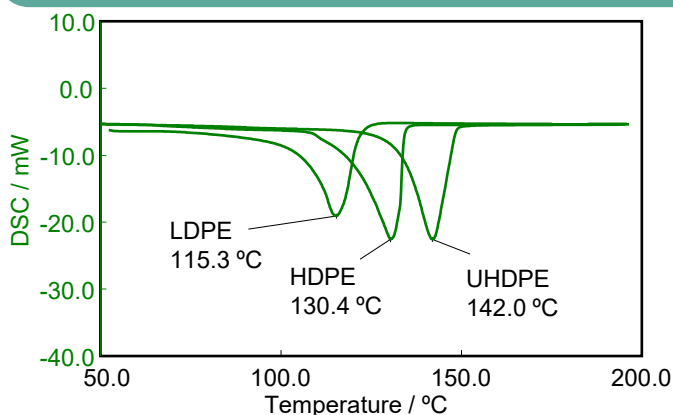
A series of commercial PEs were run on the DSC7000X using aluminum open pans. Samples were heated at 10 °C/min. Only the second heat is shown, While there is some variation in each grade, the low-density and high-density samples used are representative of grades 2 and 4, with LDPE melting at 115 and HDPE at 142 °C. As you can see, the materials are quite distinct in the DSC. In addition, we ran a medium density polyethylene. As expected, it falls directly in between the two.

In the case of a mixture of polyethylenes, the DSC detects the presence of other material by changes in the shape of the melting curve.
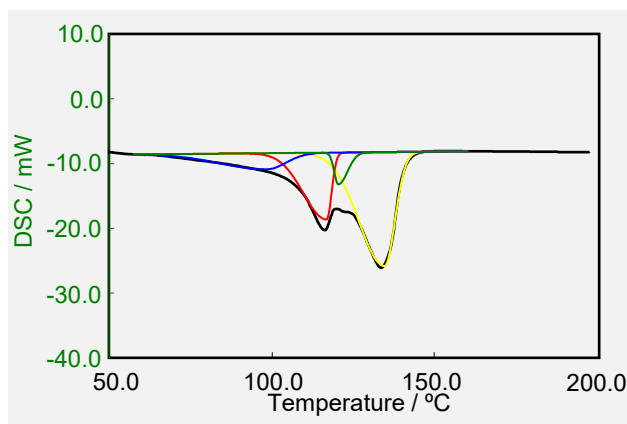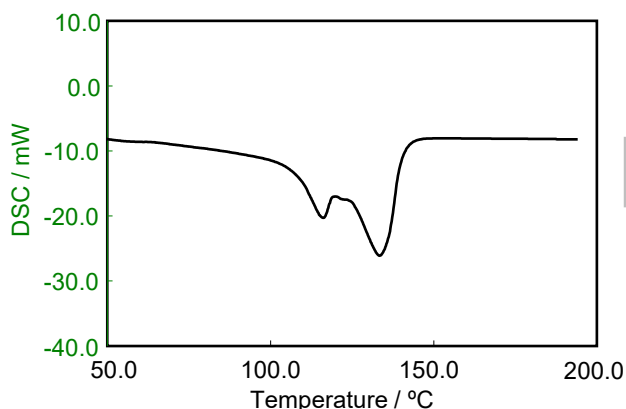
The above thermogram shows a mixture of four grades of PE One can easily seen the change from the HDPE peak. If one needs to estimate the components of the mixture, one can use the peak separation software to deconvolve the curve. One can then measure the component peaks and estimate their relative contribution.

In addition, as shown to the right, the DSC7000X will also detect small amounts of other polymers. Here less than 0.5% of polypropylene in HDPE is detected in the DSC.

The DSC7000X allows detection of grades of PE, blends, and contaminating polymers with unattended operation using the autosampler.

Hitachi High-Tech Science Corporation