Many of the research projects and initiatives aimed at improving recycling rates for plastics originate in countries which already have a strong track-record in collecting and recycling packaging polymers such as polyethylene terephthalate (PET). This widespread success with bottle PET has led researchers and businesses to look more closely at possible routes to similar success both with PET in other formats and with other polymers.

This evolution was reflected in several presentations at IAPRI's Symposium at the University of Twente, the Netherlands, earlier this summer.

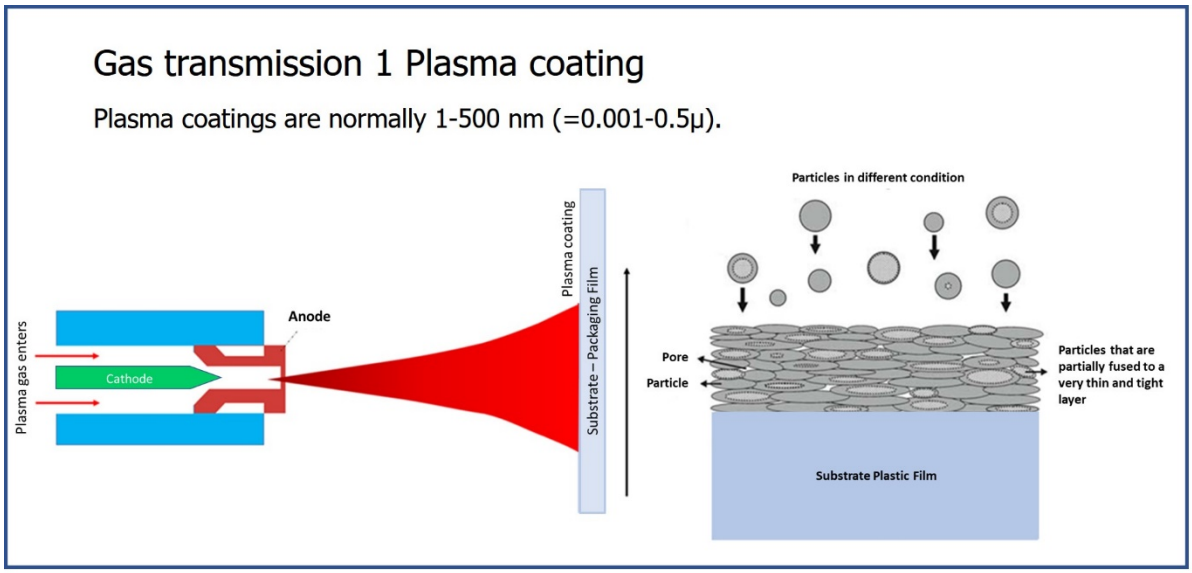
When it comes to PET, there are still untapped sources of bottles as well as other pack types, such as trays, which can yield significant volumes of highly sought-after post-consumer recyclate (PCR). But for Søren Østergaard of the Danish Technological Institute (DTI), the focus was on films.

Flexible films, of course, account for a very visible but notoriously hard-to-recycle fraction of domestic packaging waste. The aim of the DTI research was to investigate whether films made from a single polymer (and so recyclable) could replace laminates which cannot be recycled as individual polymers.

In his presentation, Østergaard enumerated the various properties required in any such film, including flexibility, sealability, printability and transparency. Suitability for food contact and (naturally) for recycling were essential. But at the top of the DTI's list of requirements - and often the main reason why multilayer laminates are used in the first place - is the ability to provide an effective gas and liquid barrier.

"In our opinion, one of the best barrier solutions is plasma coating, whether silicon oxide (SiOx), aluminium oxide (AlOx) or diamond-like carbon (DLC)," he said. "In none of these cases is a barrier laminate is required."

The use of plasma coating demands a non-stretchable base film, so that the coating does not crack and so compromise barrier. From this perspective, said Østergaard, PET is best-suited for the base film. The problems come when you start to look at the heat-seal or welding properties of PET. As he explained, most heat sealing on packaging machinery happens at below 180°C, while PET melts at 210°C.



AlOx, SiOx or DLC plasma coating can be used for barrier on PET film, says DTI.

The secret, according to the DTI research, was to apply polymers with lower sealing temperatures in only those areas where they are required, so as not to take contaminants in the PET/rPET stream above 1%, and so allow further recycling. While considering other technologies such as slot die coating and plasma coating, the team concluded that the printing of welding layers (such as polyethylene terephthalate glycol – PETG) was the most promising solution.

Elsewhere, the momentum that many markets are seeing behind bottle PET in particular is also serving to emphasise the gap between this and other plastics. If PET can be a sustainability success story, why should that not be true for other plastics, too?

For many, the focus both in terms of design-for-recycling and sorting/reprocessing has largely shifted towards monomaterial polyolefins, generally recognised as the being the next-lowest-hanging fruit after PET.

Referring to her work on the FuturePack project, Tanja Radusin of Nofima, Norway, said: "We want to close the gaps in the recycling process. Is there such a thing as 'bad plastics'? I strongly feel we need to prepare some kind of defence."

Some of that ‘defence’ has been developed as part of this Norwegian project, supported by the Research Council of Norway and led by Norner, a specialist in industrial R&D services for polymers. Radusin summarised the team’s very hands-on research in her paper ‘Sorting as a key factor for high quality of recycled polypropylene’. As she explained, polypropylene (PP) and polyethylene (PE) together make up around half of European plastics demand, and PP has roughly a 20% share in total plastics production.

She took the example of PP to demonstrate that, while there were different and incompatible sub-streams within what could be identified as PP, these challenges were not insurmountable. “From the plastics we were provided with, we were able to separate out the PP into injection-moulded, thermoformed and bottles,” Radusin said.

Tanja Radusin of Nofima (far right)

(second from the left)

Among other properties, the FuturePack team measured melt flow index (MFI), and found there was a “huge difference” between the various grades converted using this range of processes. While injection moulding grades had an MFI of 63g/10min, the MFI for black PP for thermoforming was just 1.4g/10min. “The commercial waste output is somewhere between the two, so can’t be used for either thermoforming or injection-moulding,” Radusin explained.

She added: “We would strongly suggest that the level of fine sorting we have demonstrated is a key to success for industry, in order to obtain high-quality recyclates for use in packaging applications.”

As the Symposium papers delivered by Radusin's colleague at Nofima Marit Kvalvåg Pettersen demonstrated, FuturePack also has a focus on design-for-recycling. In the case of her presentations, it was to do with showing that lower-barrier polyolefins can work well with products such as fish and meat products, even as a replacement for barrier laminates – and even where product shelf-life relies on modified atmosphere packaging (MAP). These papers were discussed in the May 2019 newsletter.

The paradox was picked out during the Sustainability Working Group (WG) meeting that, at the very time when public awareness of plastics, especially, as an environmental issue was stronger than ever, the economic framework around recycling - in many markets - was especially weak. WG Chair Carlos Diaz of Rochester Institute of Technology (RIT) said: "California is proposing new minimum recycled content in plastics, but at the same time, recycling facilities are being closed down."

Those tough business conditions were confirmed in early August when California's largest operator of recycling redemption centres RePlanet announced that it was closing all 284 of its centres. Three years earlier, it had closed 191 of them. The Canadian company blamed higher business costs and falling prices of aluminium and PET.

Also at the Sustainability WG meeting, and specifically addressing the issue of recycled plastics, Rafael Auras of Michigan State University (MSU) pointed out: "PCR has to compete with virgin polymer at a time when there are millions of tonnes of it on the market [in North America] as a result of the fracking boom."

Europe is not immune to these types of conflict of interest. The EU Commission has devoted huge amounts of energy to mapping out its Circular Economy strategy. But as Radusin at Nofima indicated, the fact that it has only approved the use of a few recycling processes limits reprocessing options when seeking high-quality outcomes.

Chris Bruijnes of the Netherlands Institute of Sustainable Packaging (KIDV) noted in his Symposium keynote address: "When judging sustainable packaging, recyclability, circularity and environmental impact are like three bullets which are not necessarily aimed, always, in the same direction."

Framing the same issue slightly differently later in his presentation, he stated: "We're designing for recycling and we want a circular economy, but in fact there's a big gap between the two."

But even while more questions are being asked about how recycling sits with other aspects of sustainability, it is becoming clearer that research has a real role to play in helping to build longer-term viability into the sector.