



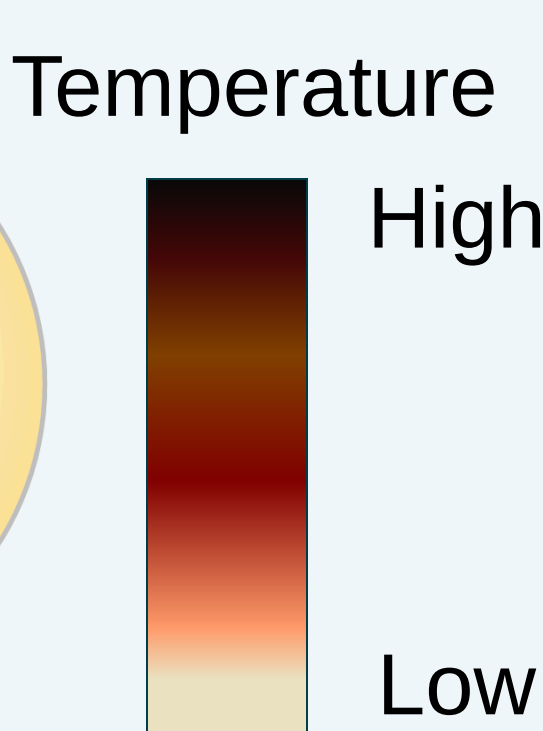
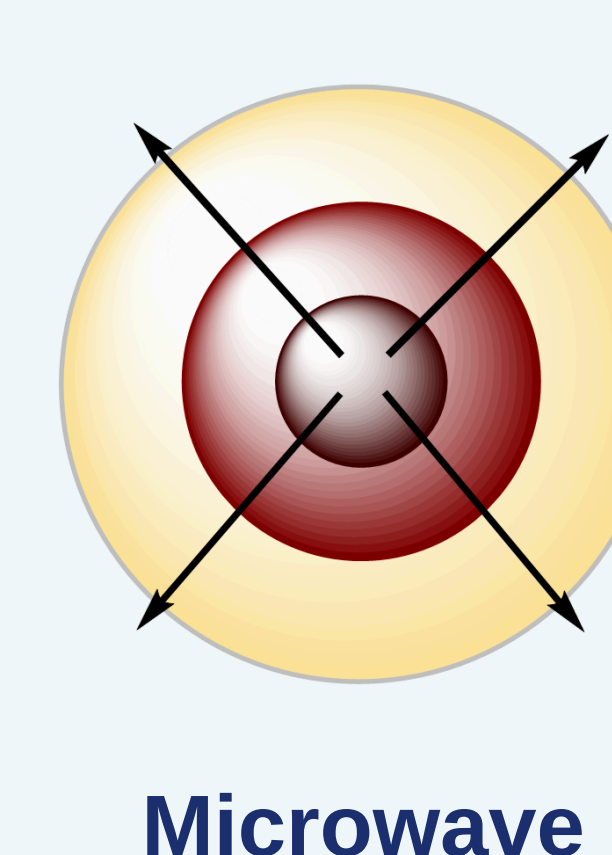
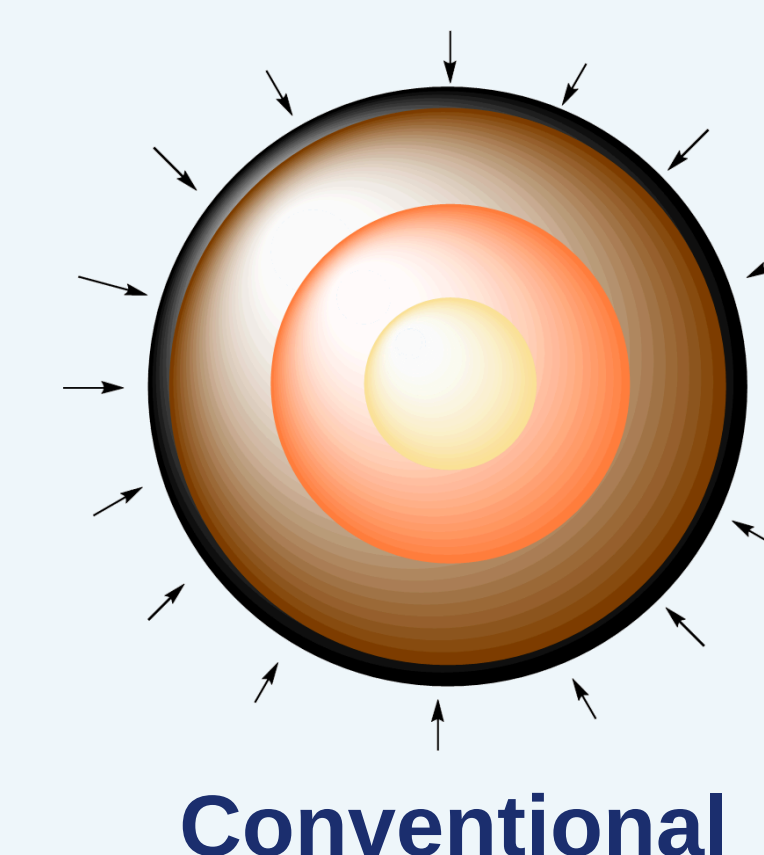
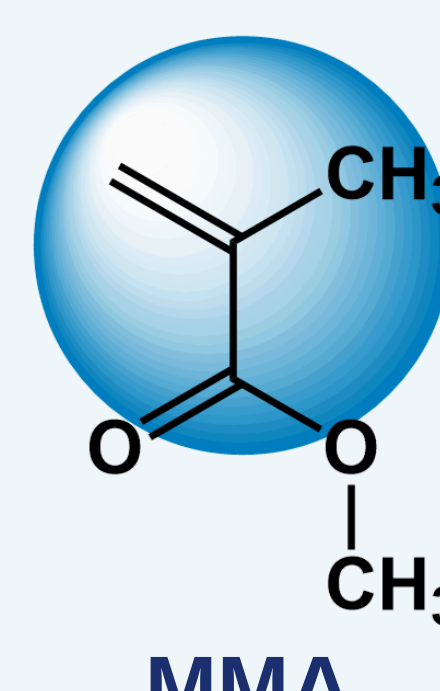
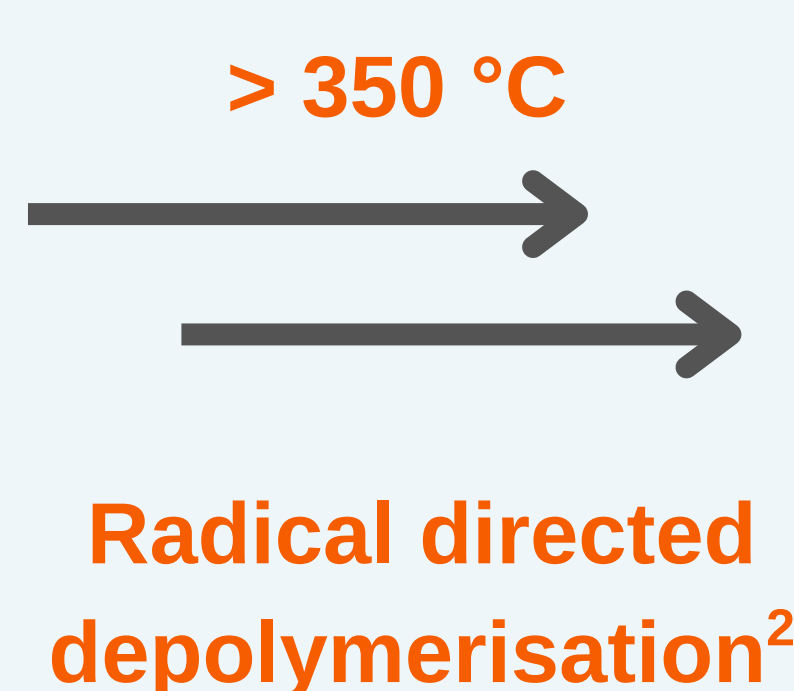
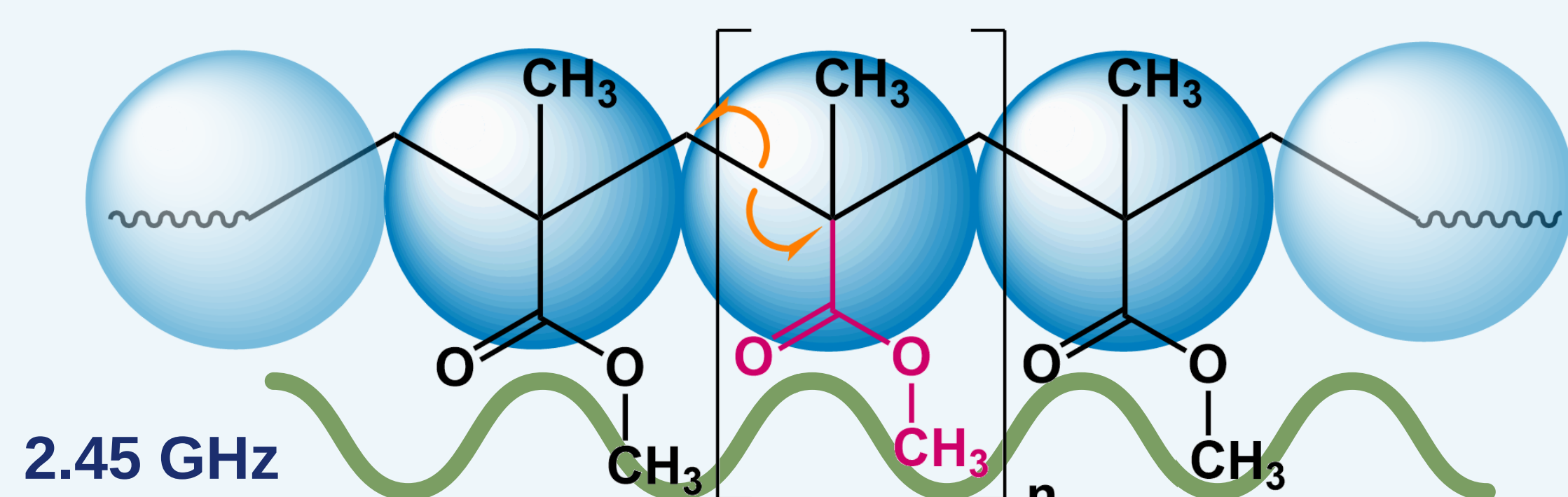
Higher yield, Higher purity: Microwave pyrolysis of commercial poly(methyl methacrylate)

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INTRODUCTION



- Conventional chemical recycling technologies¹ can recover > 95 % MMA monomer from PMMA, but are energy intensive, require extensive downstream purification, and result in unwanted toxic contaminants.

- Microwave processing** can heat volumetrically, overcoming conventional processing challenges, and provide a **low carbon route to acrylic circularity**.
- PMMA pendant group is polar therefore can undergo dielectric heating³

PYROLYSIS

- Analogous conventional and microwave pyrolysis systems developed.
- Stepwise depolymerisation** - series of pyrolysis runs completed at incremental conversions.
- Depolymerisation temperature investigated by varying power input on microwave generator.

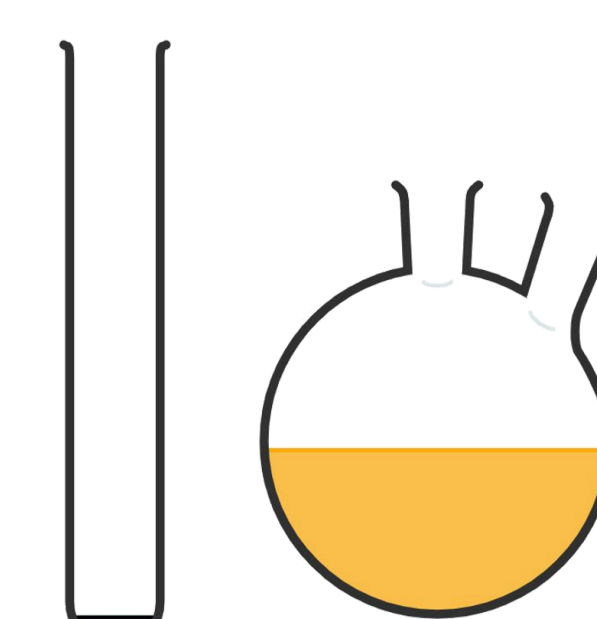


Clear Cast
Sheet PMMA

- Conventional:
450 °C, N₂
- Microwave: 200 -
1400 Watts, N₂

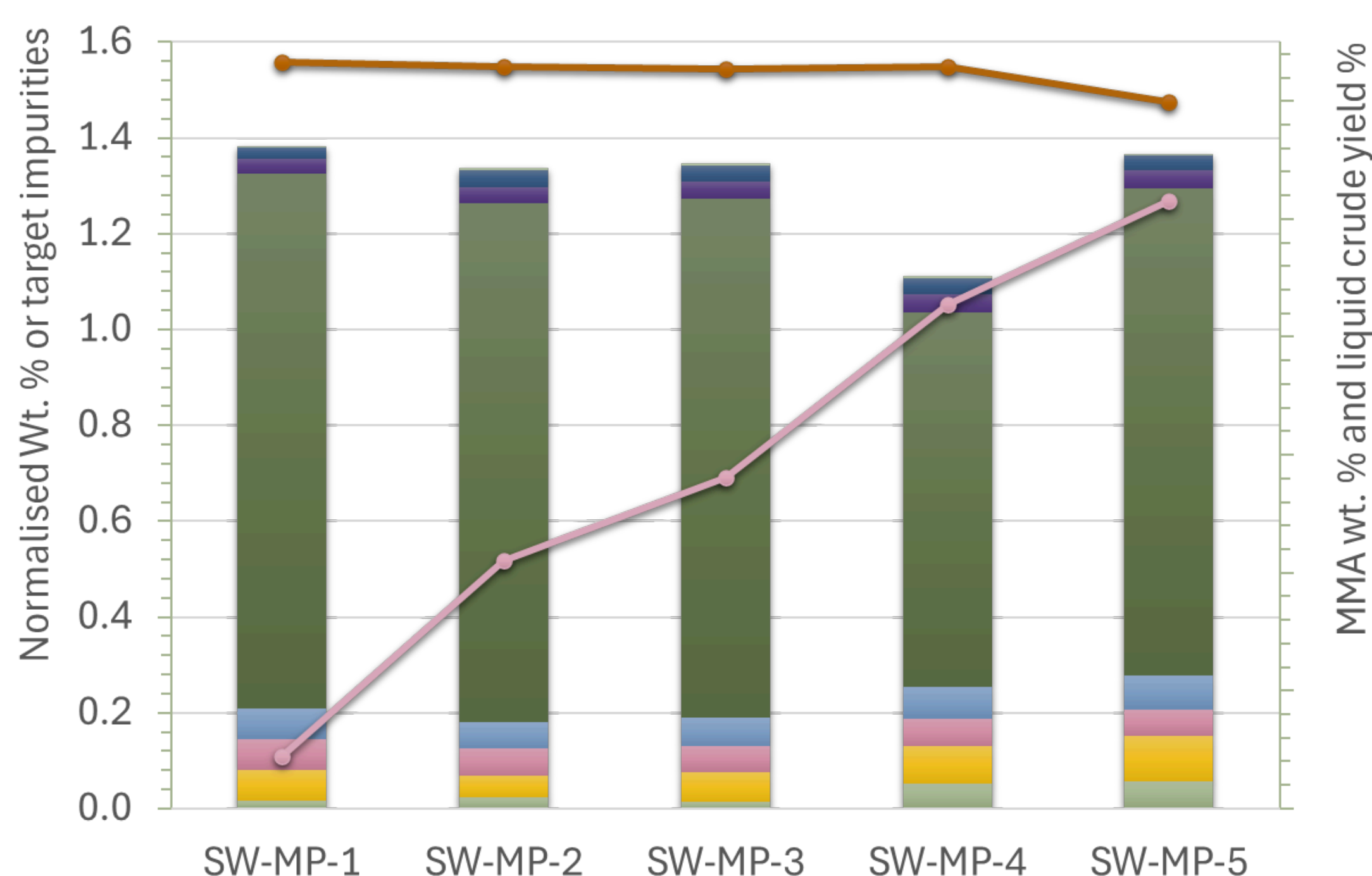


Understand microwave
interactions with polymers

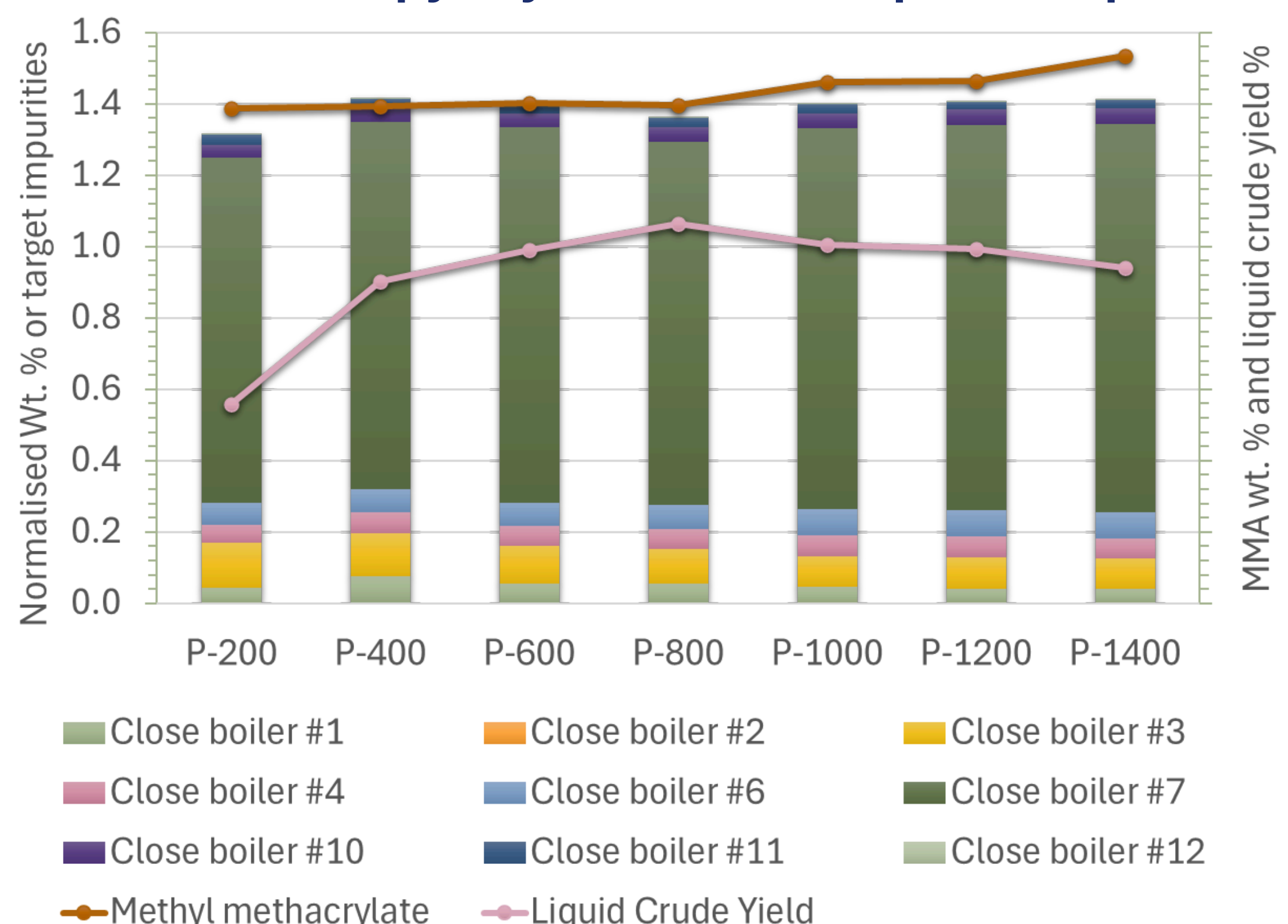


50, 70, 90, 95, 100
% Conversion

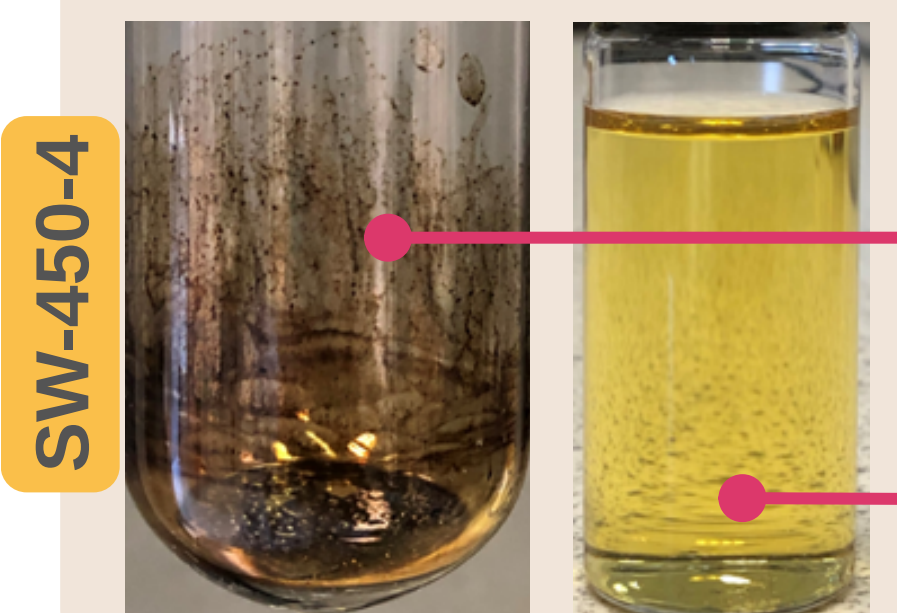
GC-MS/FID quantification of crude liquid product



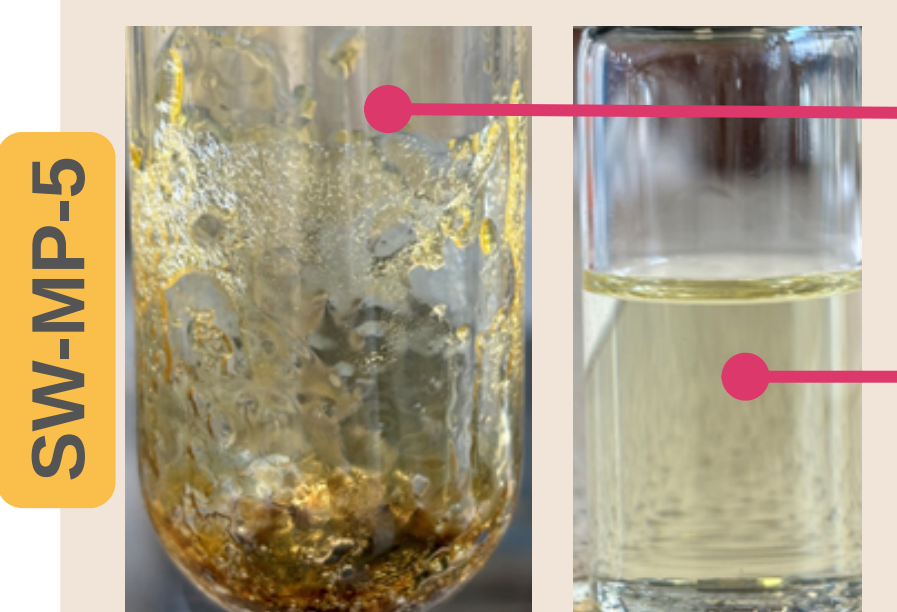
Microwave pyrolysis at various power inputs



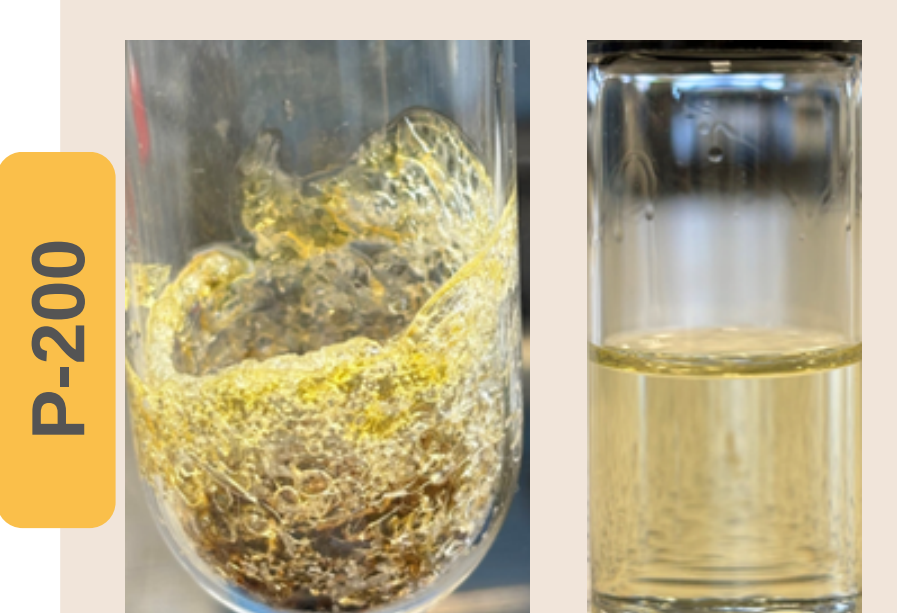
Conventional



Microwave



800 W, 350 °C



200 W, 300 °C



1400 W, 400 °C

RESULTS & DISCUSSION

- High furnace temperatures resulting in secondary degradation of MMA reducing monomer recovery and char formation.
- Discoloured crude liquid product indicative of higher concentration of impurities.
- Complete conversion can not be achieved below 350 °C.
- Lower** char content due to **cooler** environmental temperatures resulting in less yellowing of liquid crude.
- Lower** concentration of close boilers than conventional pyrolysis.
- High MMA recovery** at the respective conversion due to fewer impurities resulting from improvements to kinetically favourable depropagation unzipping mechanism.
- Power input for microwave pyrolysis can be increased without increasing impurities as system reached 400 °C plateau above 800 W, facilitating higher conversion and minimised impurity formation.
- Thermally stable structures⁴ formed in-situ force higher depolymerisation temperatures for complete degradation resulting in further impurities, char formation and discolouration.

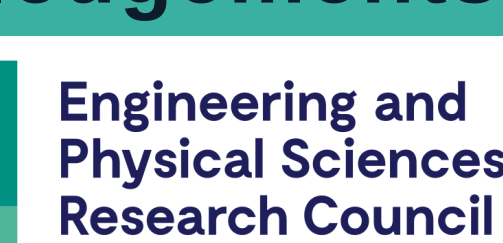
CONCLUSION

- Microwave pyrolysis produced a liquid crude with significantly less discolouration, and **better product purity and MMA recovery** facilitating less capital and energy for purification than conventional pyrolysis, **reducing product carbon footprint**.

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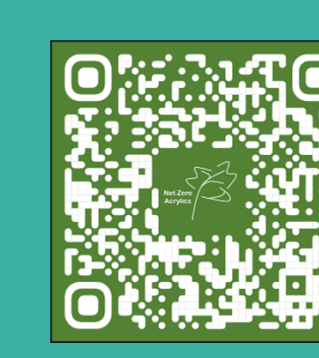
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