ZCoRe: Biobased Phthalic anhydrides for UPR synthesis and as curing agents for epoxides.

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1 Introduction

Partner company TNO/Relement gains C5-sugars from seaweed waste and uses those sugars to synthesise phthalic anhydride and its analogues depicted in fig. 2. Their goal is to sell these partially biobased molecules as building block to industrial companies. However, research needs to be done on the performance of these analogues compared to phthalic anhydride. This is where CoE BBE/Avans start to play a role. In the past two years CoE BBE has tested different applications for the analogues. The most promising applications were unsaturated polyester resins (UPR's) and curing agents for epoxy resins.

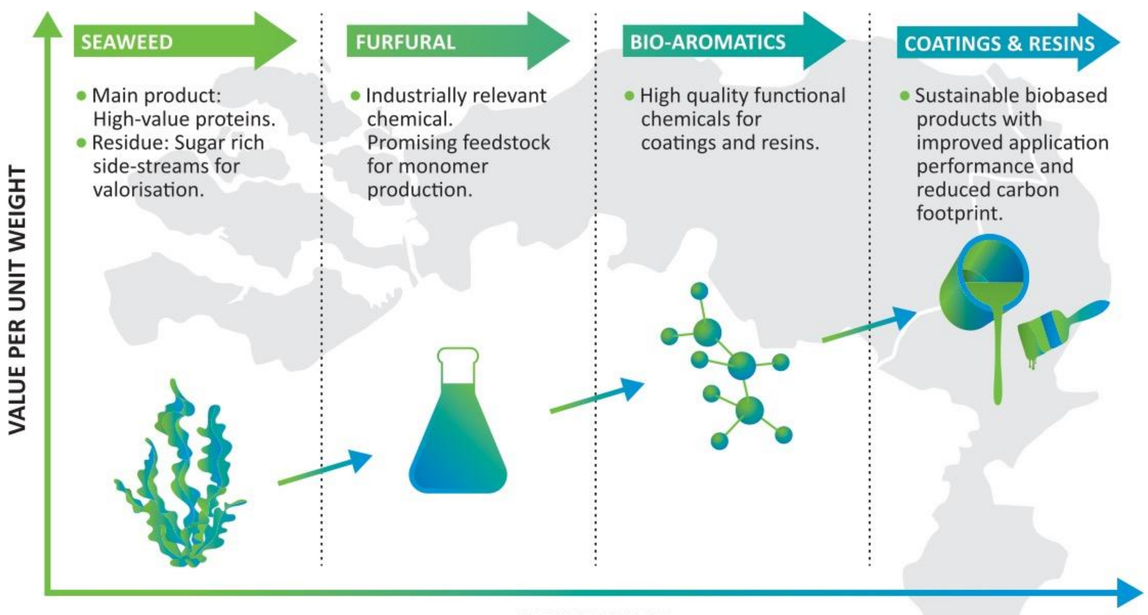

Figure 1. Schematic representation of the Z-core project.

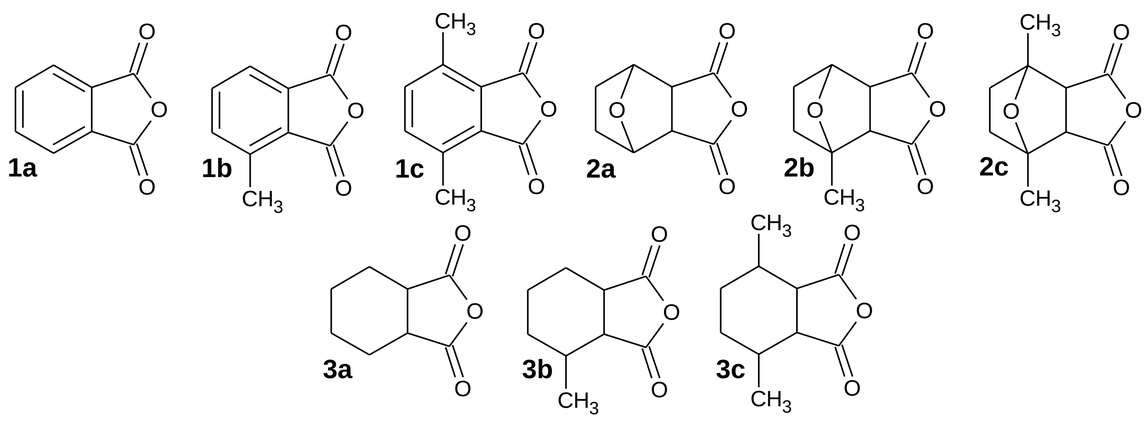

Figure 2. Overview of seaweed based PA analogues

2 Unsaturated polyester resins

UPR's are one of the most essential classes of thermosetting crosslinkable resins with widespread uses in coatings, construction and composites. The goal of this research project was to set up a method to synthesize UPR's using analogues 1a, 1b, 2a and 2b, where the analogues would be incorporated into the polyester chain. To investigate the composition of the UPR's, a ^{1}H-NMR method was developed.

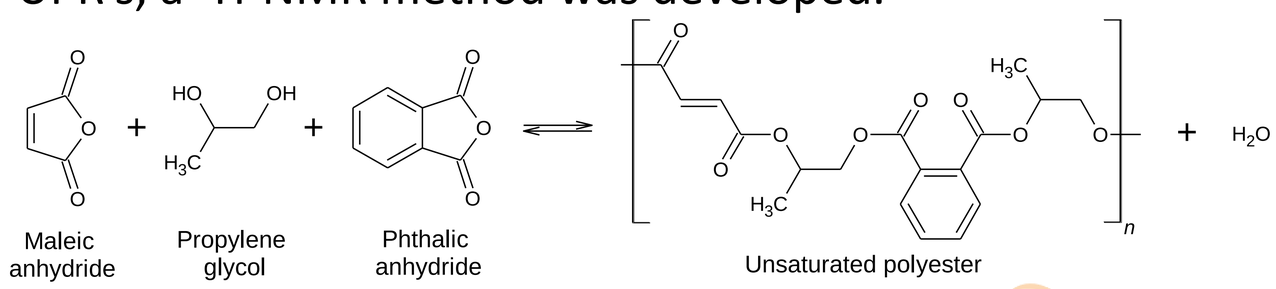

Figure 3. Reaction scheme of the production of a UPR with PA.

3 UPR Results

Due to differences in reactivity of the analogues, two-step addition of the anhydride with p-toluenesulfonic acid catalyst had to be performed to ensure that the analogues were incorporated into the polyester chain.

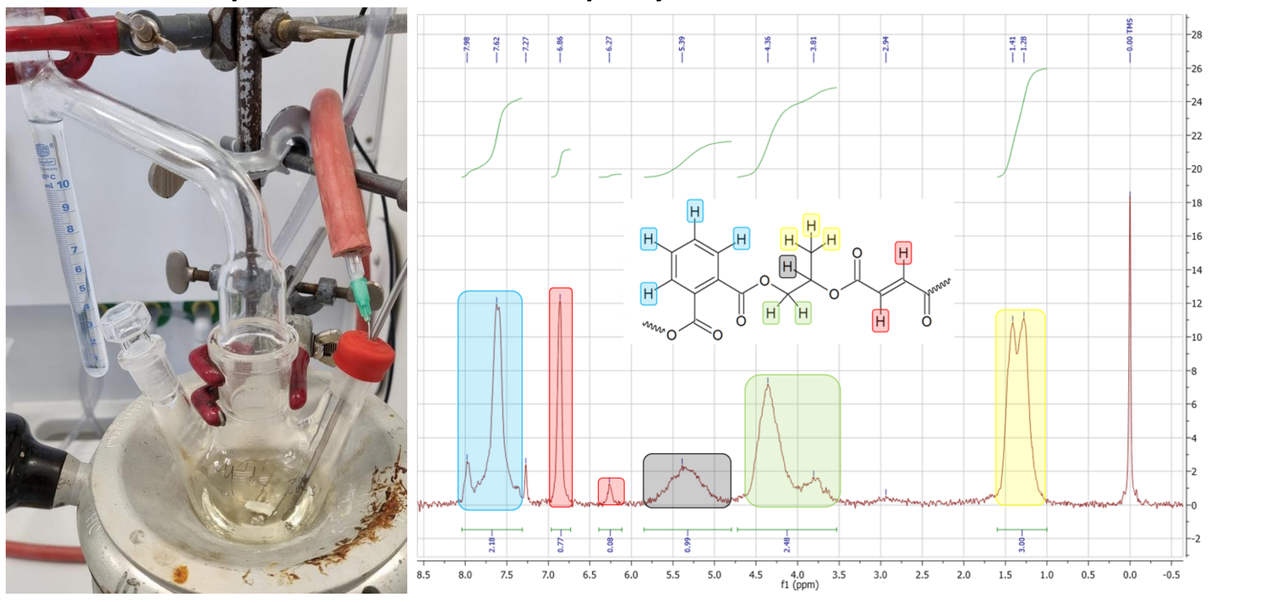
Figure 4. Left: reaction setup. Right: 1H-NMR spectrum of a UPR with PA.

4 Curing agent for epoxide resins

The goal of this research was to assess the performance of the phthalic anhydride analogues as curing agent for epoxy systems. This has been done with a catalysed formulation using DAR332 (Bisphenol A resin) and the tertiary amine dimethylbenzylamine. The reactivity and T_g have been determined with isothermal and dynamic DSC measurements. The gel-content, degradation temperature, and scratch resistance also have been measured.

5 Epoxy Results

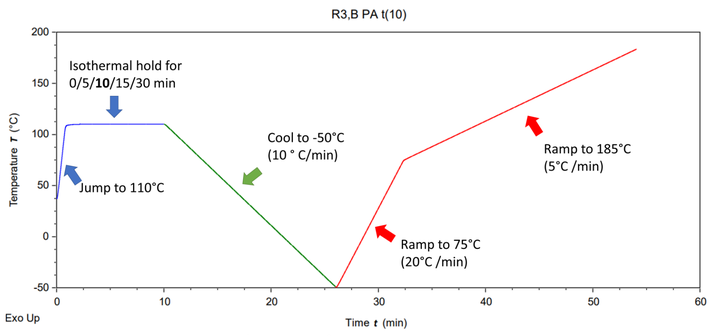

Figure 5. Developed DSC program.

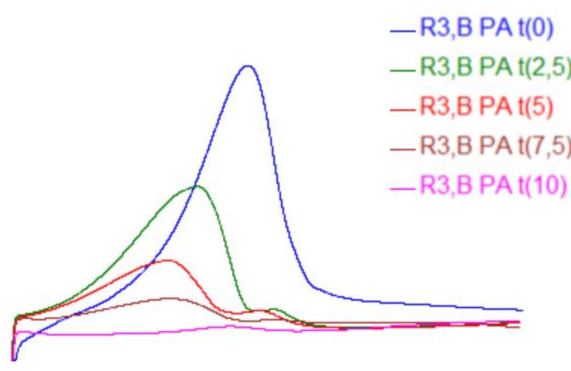

Figure 6. Overlay of the reaction enthalpy from the reaction with PA.

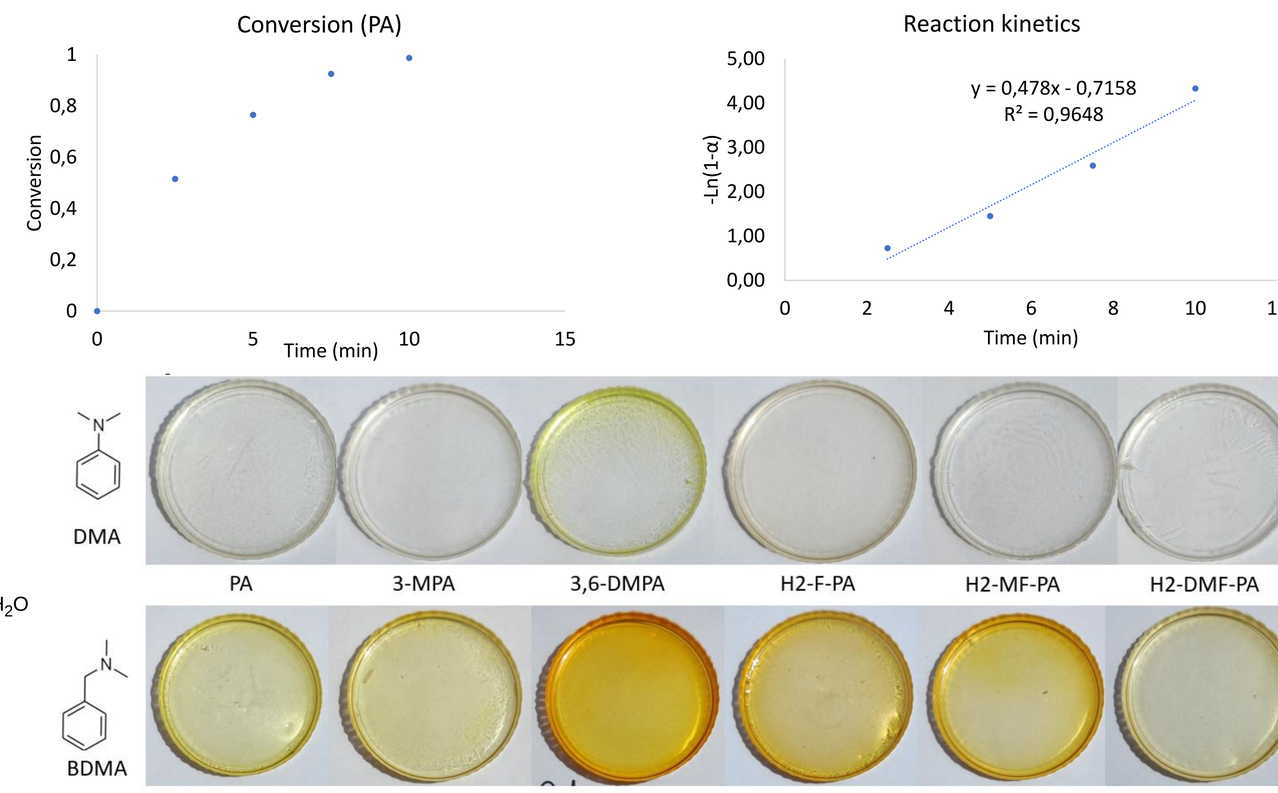

Figure 7. Overview of the oven cured samples. (90°C for 24h).

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