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Structure–Reactivity Relationships in Catalyst-Free Curing of Epoxy Resins with Carboxylic Acids

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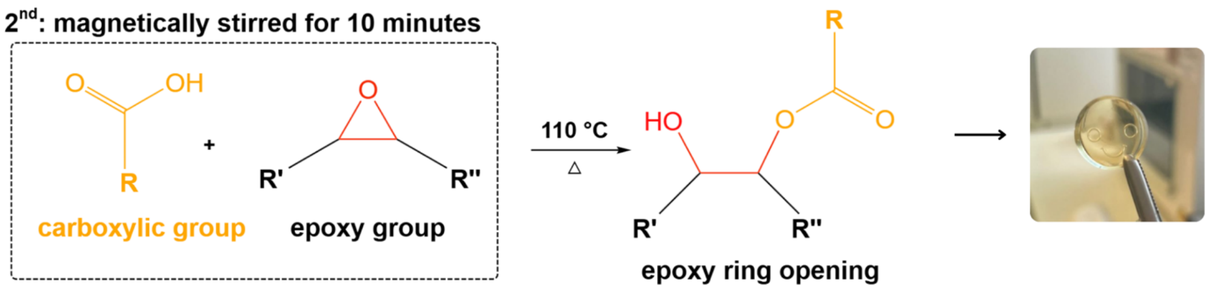
INTRODUCTION AND AIM

Epoxy resins are widely used due to their excellent chemical resistance, thermal stability, and mechanical strength. Conventional curing agents, such as amines and anhydrides, pose environmental and processing drawbacks. This study explores sustainable alternatives using carboxylic acids—salicylic, citric, and maleic acids—as catalyst-free curing agents. The work aims to evaluate their efficiency in promoting epoxy ring-opening and crosslinked network formation, emphasizing the influence of acid structure on curing performance.

METHODOLOGY

1st: heated to 80 °C;

2nd: magnetically stirred for 10 minutes



RESULTS AND DISCUSSION

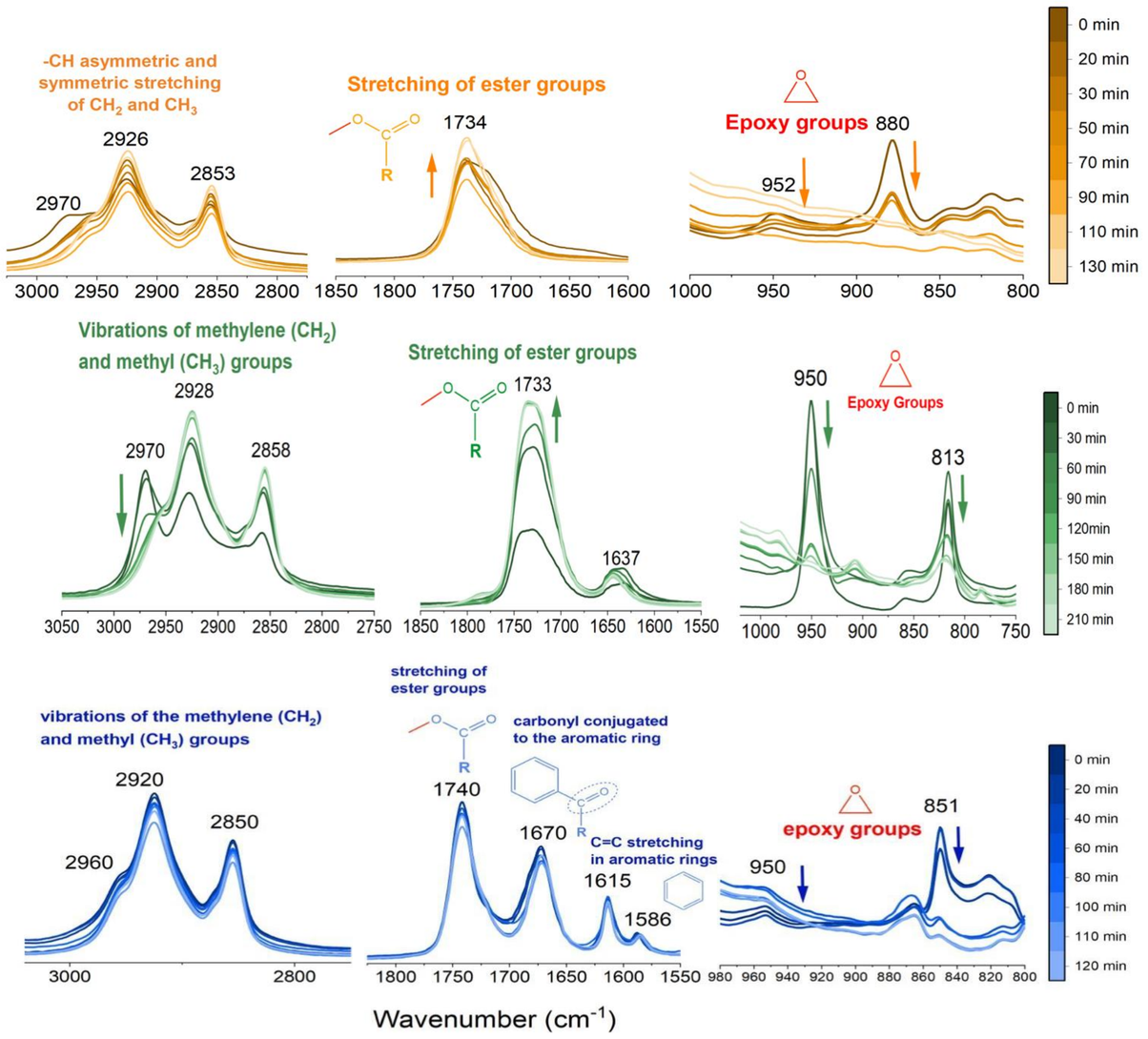


Figure 1. FTIR spectra of the indicated compositions: (a) ESO/CA, (b) ESO/MA and (c) ESO/SA.

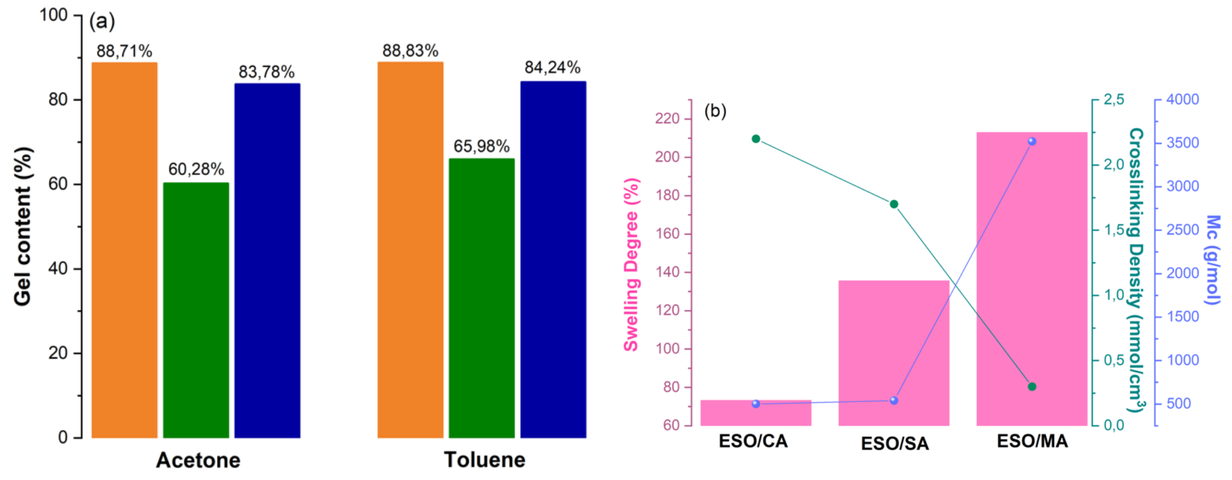


Figure 2. (a) Gel content of epoxy resins in acetone and toluene, and (b) influence of carboxylic acid type on swelling ratio in toluene, crosslink density, and molar mass between crosslinking points (Mc). Orange: ESO/CA; Green: ESO/MA; Blue: ESO/SA.

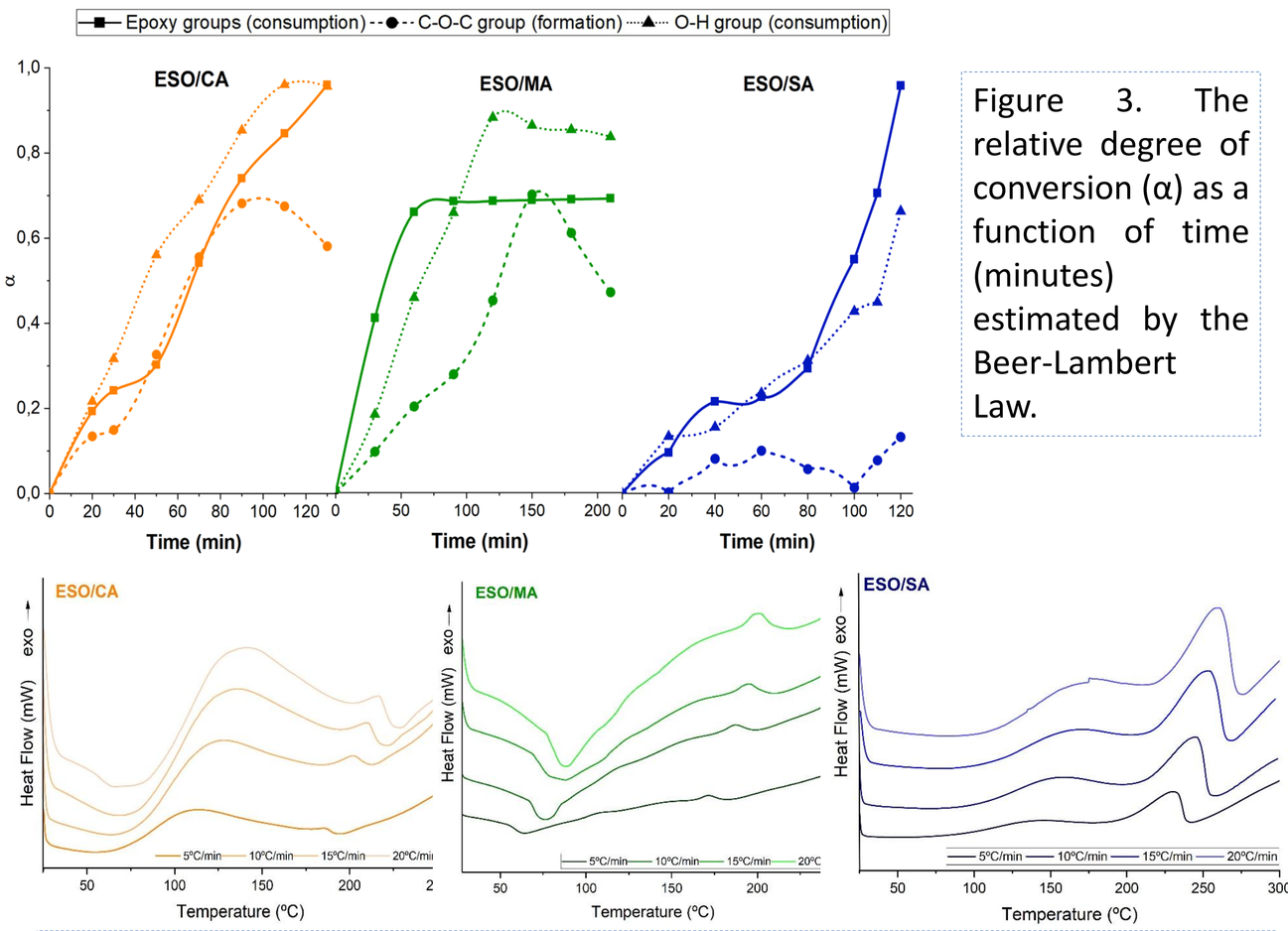


Figure 3. The relative degree of conversion (α) as a function of time (minutes) estimated by the Beer-Lambert Law.

Figure 4. DSC curves for ESO/CA(a), ESO/MA(b), and ESO/SA(c) at different heating rates (5° C/min, 10° C/min, 15° C/min, and 20° C/min).

CONCLUSION

FTIR confirmed epoxy ring-opening for salicylic and citric acids, indicating successful curing. DSC analysis showed higher curing efficiency and thermal stability for citric acid. Gel content supported these findings, revealing a higher crosslink density in citric acid–cured samples.

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