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# Multivariate Curve Resolution using a Combination of Mid-Infrared and Near-Infrared Spectra for the Analysis of Isothermal Epoxy Curing Reaction

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## Abstract

Multivariate curve resolution (MCR) was applied to a hetero-spectrally combined dataset consisting of mid-infrared (MIR) and near-infrared (NIR) spectra collected during the isothermal curing reaction of an epoxy resin. An epoxy monomer, bisphenol A diglycidyl ether (BADGE), and a hardening agent, 4,4'-diaminodiphenyl methane (DDM), were used for the reaction. The fundamental modes of the N-H and O-H stretches were highly overlapped in the MIR region, while their first overtones could be independently identified in the NIR region. The concentration profiles obtained by MCR using the hetero-spectral combination showed good agreement with the results of calculations based on the Beer-Lambert law and the mass balance. The band assignments and absorption sites estimated by the analysis also showed good agreement with the results using two-dimensional (2D) hetero-correlation spectroscopy.

Key-Words

Mid-infrared spectroscopy; Near-infrared spectroscopy; Multivariate curve resolution; Two-dimensional hetero-correlation spectroscopy; Epoxy resin; Curing reaction

## Introduction

The curing process of an epoxy resin proceeds as a function of time with multiple and complicated chemical reactions [1-13]. The curing reaction is performed by mixing an epoxy monomer with a hardening agent such as a polyamine. The physical properties of the cured resin are controlled by the hardening agent and curing conditions, such as temperature and pressure. Epoxy resins are widely used as adhesive agents, coating materials, and insulation for electrical circuits owing to their excellent material properties as well as their simple preparation [14-21]. A viscous fluid of the mixture is converted to a plastic resin via a gelation point, resulting in the formation of a