

## Is the gravimetric water content true? NIR spectroscopy gives an answer for polymers and composites

A common way to measure water content is by weighting the polymer or a composite sample, using a gravimetric method. This method often overlooks that there is already some water inside the initial (mistakenly called “dry”) material. In reality, some water is already present in the initial material, because water is getting absorbed from air, since air has some water in it – humidity of the air. For the studied amine-cured epoxy polymer, the true water content at initial conditions is already 18% of the saturation value. These conditions are what would usually be denoted as a “dry” material... which is quite far away from being really dry. Thus, already from the beginning, the initial water content is significant and cannot be neglected.

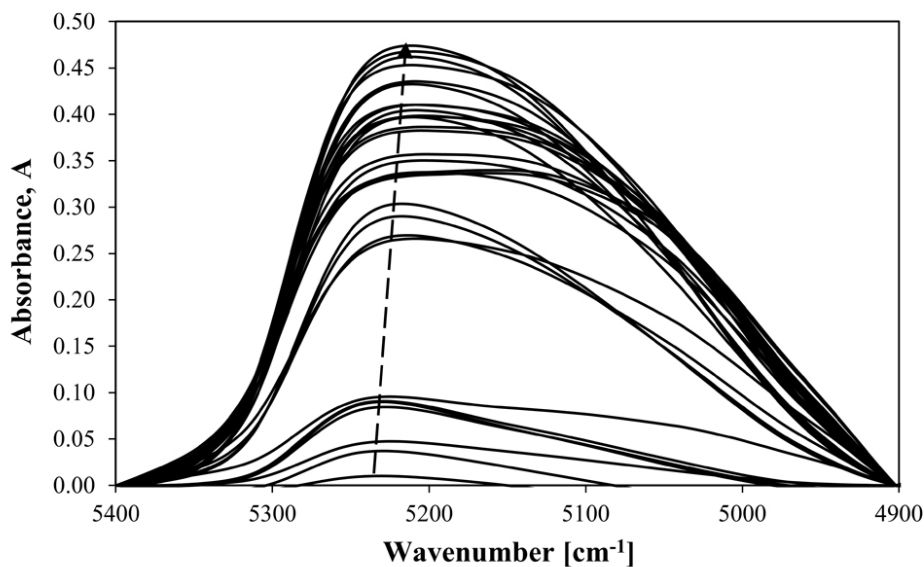


Fig. 1. The more water is inside the polymer, the more intense the peak.

Recent improvements of Near-Infrared (NIR) spectrometers have lowered the threshold for using this method for monitoring applications. NIR has a broad range of practical applications, both in the laboratory and industry, the evaluation of diffusant content being one of those. For instance, NIR spectroscopy has long been used in such fields as medicine, food and polymers.

A spectroscopic method presented in this work allows measuring the true water content conveniently and quite easily for both polymers and composite material samples. The basis for this Fourier Transform Near-Infrared (FT-NIR) spectroscopic method is the Beer-Lambert law. For this case, this law shows that the more water is inside the material, the higher is the intensity of the peak (Fig. 1). The maxima of the absorbance band at about  $5200\text{ cm}^{-1}$  in the NIR combination mode region relates to the true water content. Thus, there is a direct link between the amount of water inside of the analyzed material and the intensity of the spectroscopic signal. In practical applications, this method allows to deduce the amount of water, or the true water content in

the polymer or the composite, by measuring the intensity of the peak. The details of the method are described in the paper.

A spectroscopic method and model based on the Beer-Lambert law were successfully extended for glass fiber-epoxy composites. The fit between experimental data and the model prediction is shown in Figure 2. The figure indicates a peak intensity or absorbance vs. the true water content of the polymeric fraction of the composite.

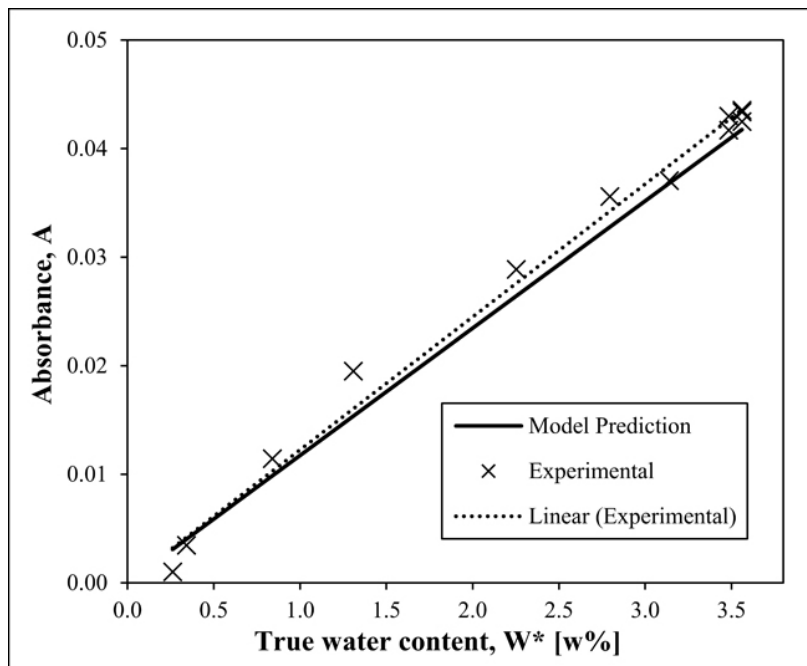


Fig. 2. The NIR spectroscopic method is capable of predicting true water content.

The method presented in this work can also be useful for other polymers and composite systems with different fiber fractions, as well as for monitoring diffusion in of liquids other than water.

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## Publication

[Near-Infrared Spectroscopic Method for Monitoring Water Content in Epoxy Resins and Fiber-Reinforced Composites.](#)

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