

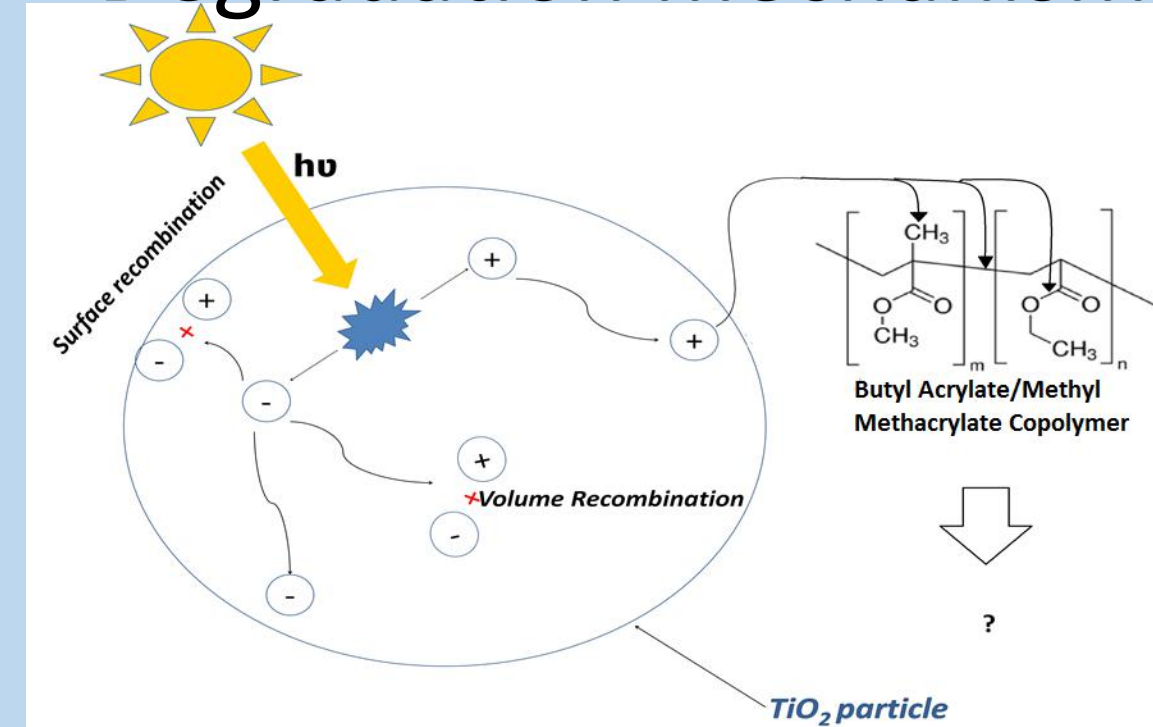
Predictive models for Service Life of Architectural Waterborne Coatings under Multi-factor Accelerated Weathering Exposures.

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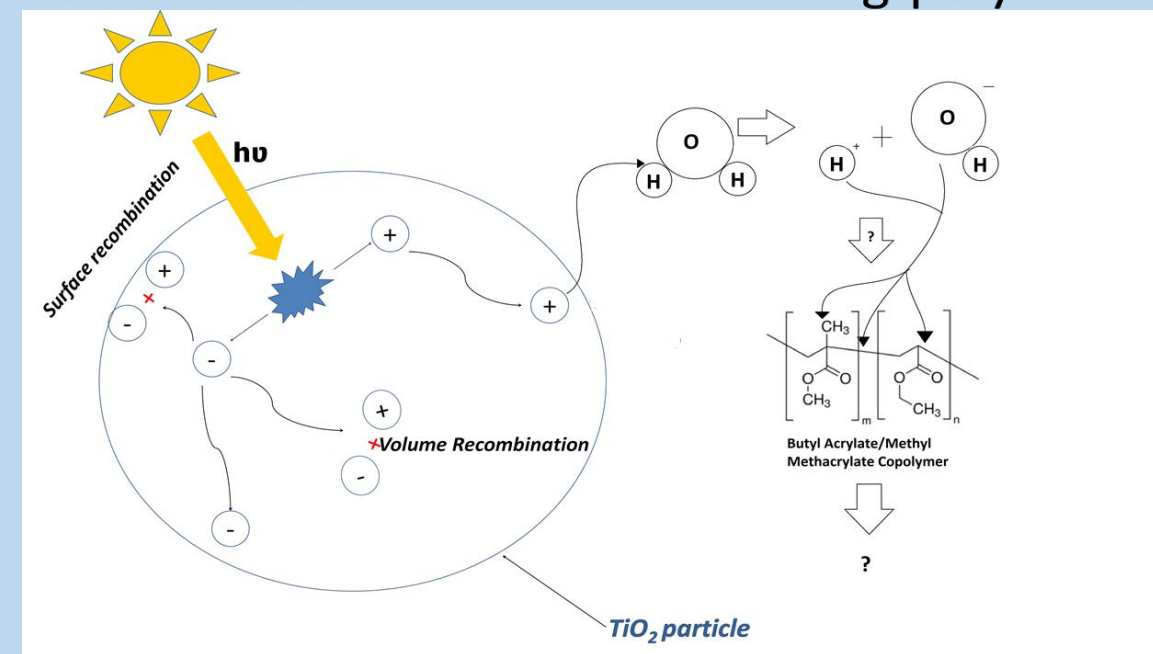
Introduction

- exterior waterborne acrylic coating systems concern the durability significantly.
- The goal of this study is to investigate the effect of TiO_2 pigments on the photodegradation of polyacrylate system and build up a structural equation modeling for lifetime prediction
- use FTIR to tracks the functional group changes as a material degrades.
- build a R package to analyze the data from different FTIR data
- use semi-gSEM to predict the degradation.

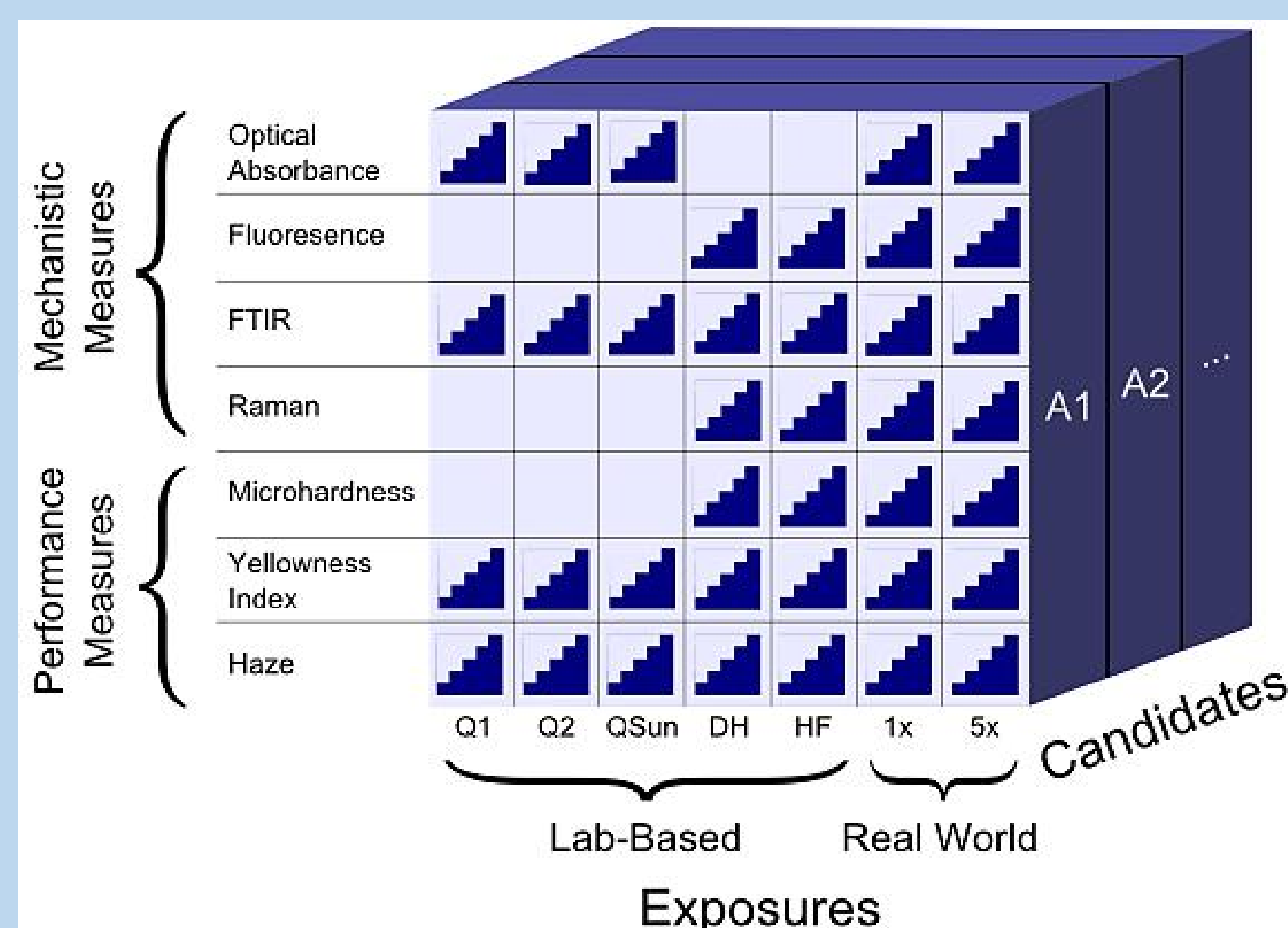
•Degradation mechanisms



Mechanism 1: UV light strikes a TiO_2 particle, exciting its valence electrons, giving them a chance to escape the band gap of TiO_2 . These escaped electrons will act as free radicals to break bonds within surrounding polymer.



Mechanism 2: Water is present, and excited electrons ionize the water into very reactive H^+ and OH^- ions, which quickly break down surrounding polymer.



Results and Discussion

baseline correction:
remove the background noise of impurity in the air.

Normalization:
bring the loudest peaks of the signal up to the highest level

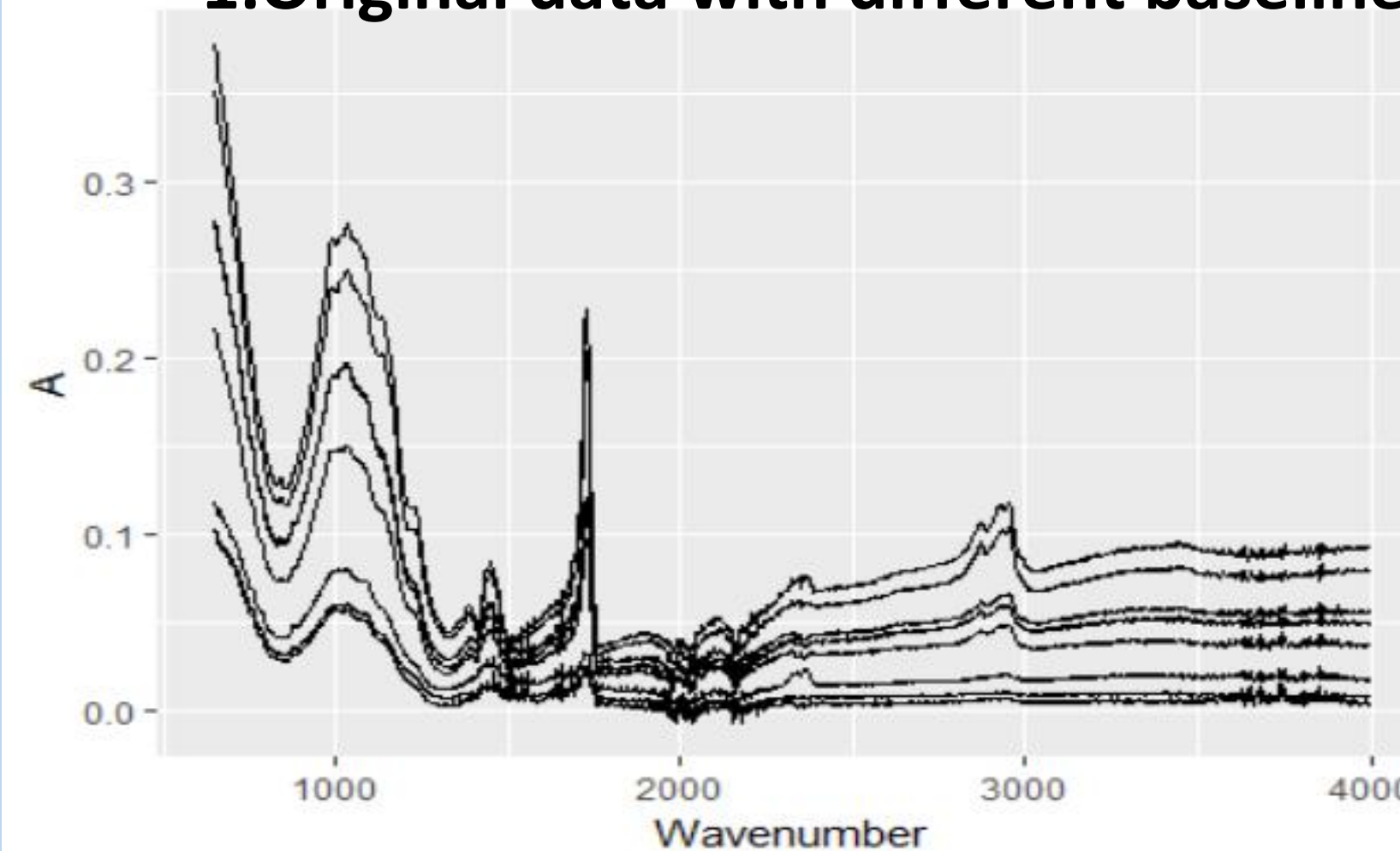
Deconvolution:
decompose the peaks that overlap with each other, extract information about the "hidden peak".

PCA:
- reduce the multi-dimensionality of the FTIR data into its most dominant components or scores
- maintaining the relevant variation between the data points.

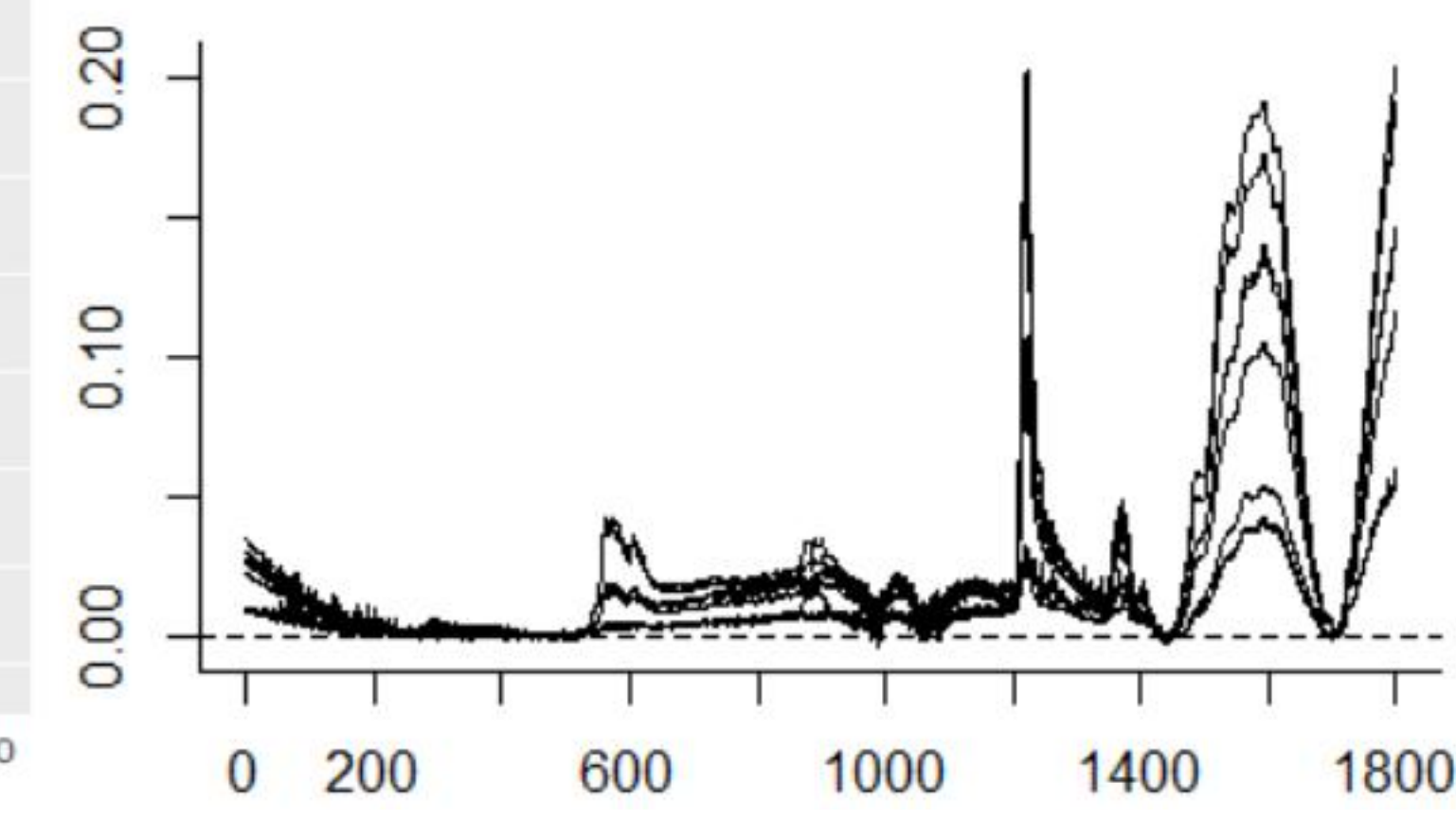
To predict the degradation mechanism with quantitative FTIR data

-mixed/fixed effects models and netSEM models are built to find the relationship between measured responses and length of exposure time under different exposure conditions.

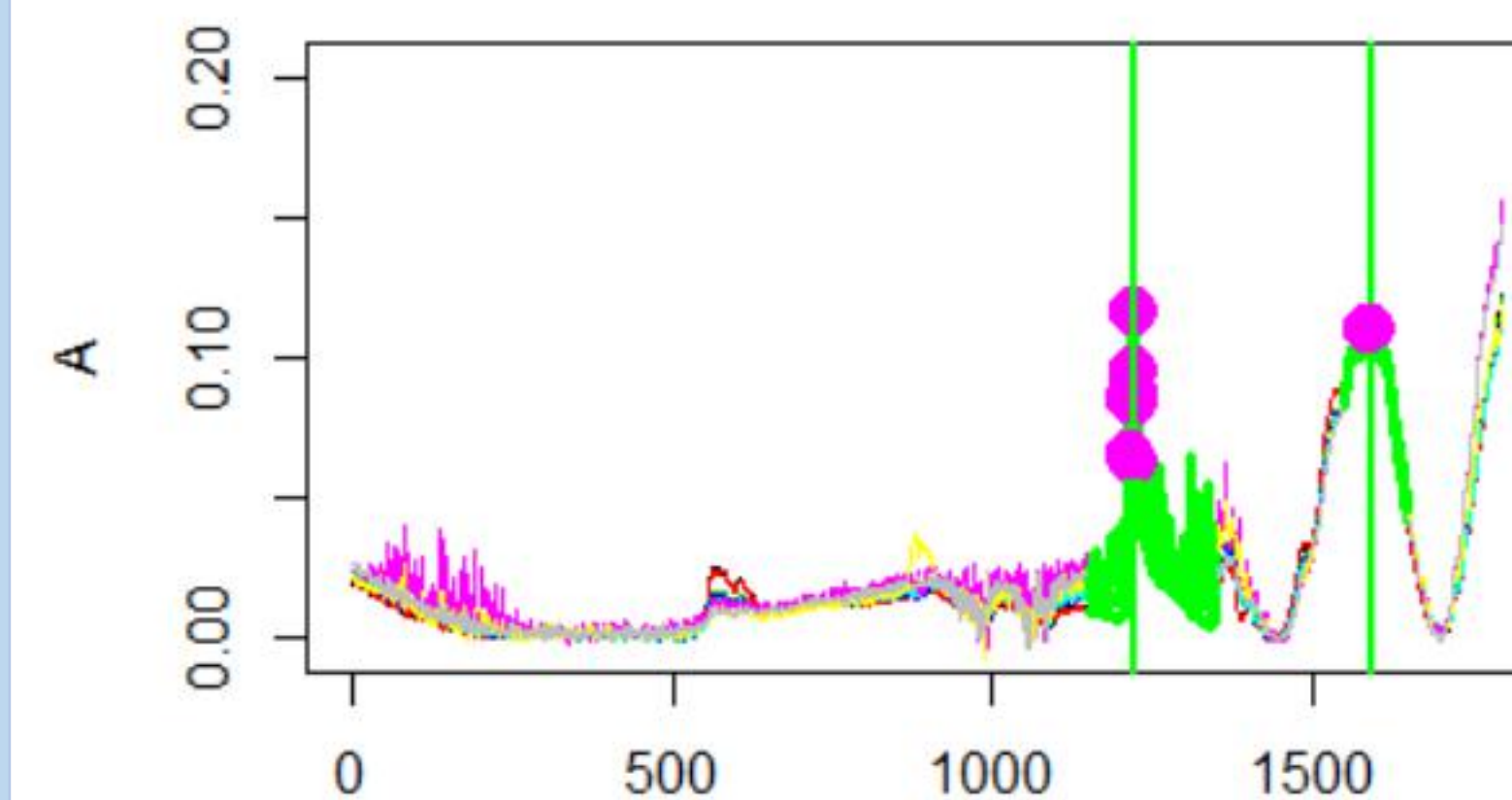
1.Original data with different baseline level



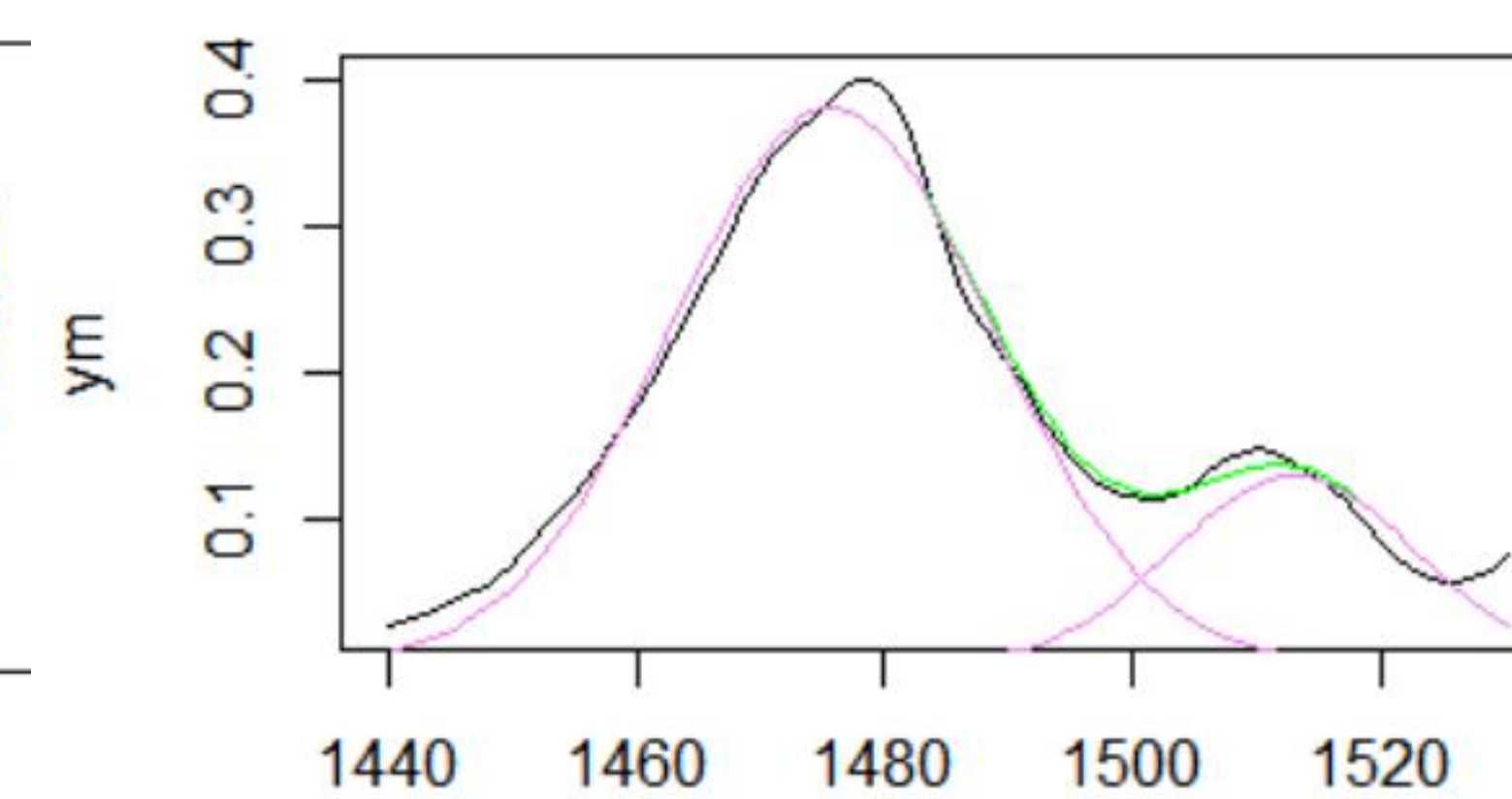
2.Baseline correction



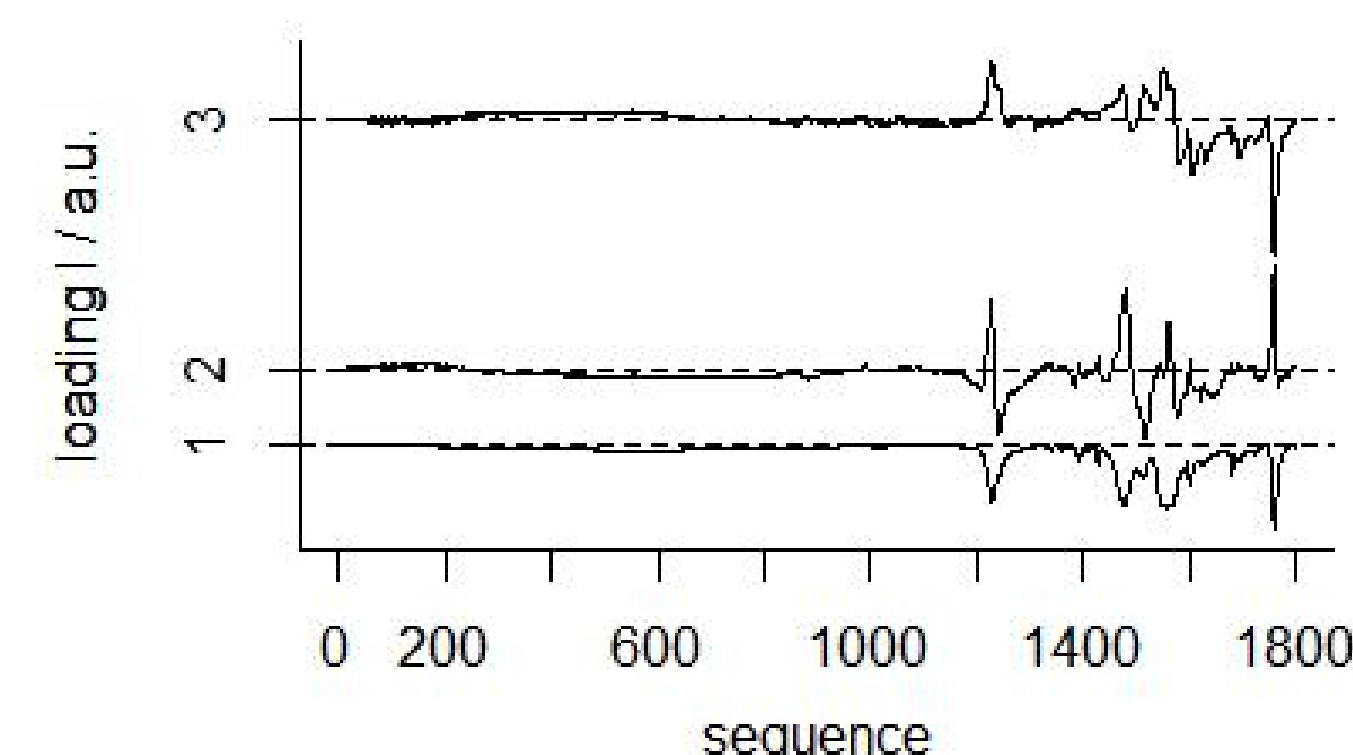
3.Normalization& peak ratio calculation



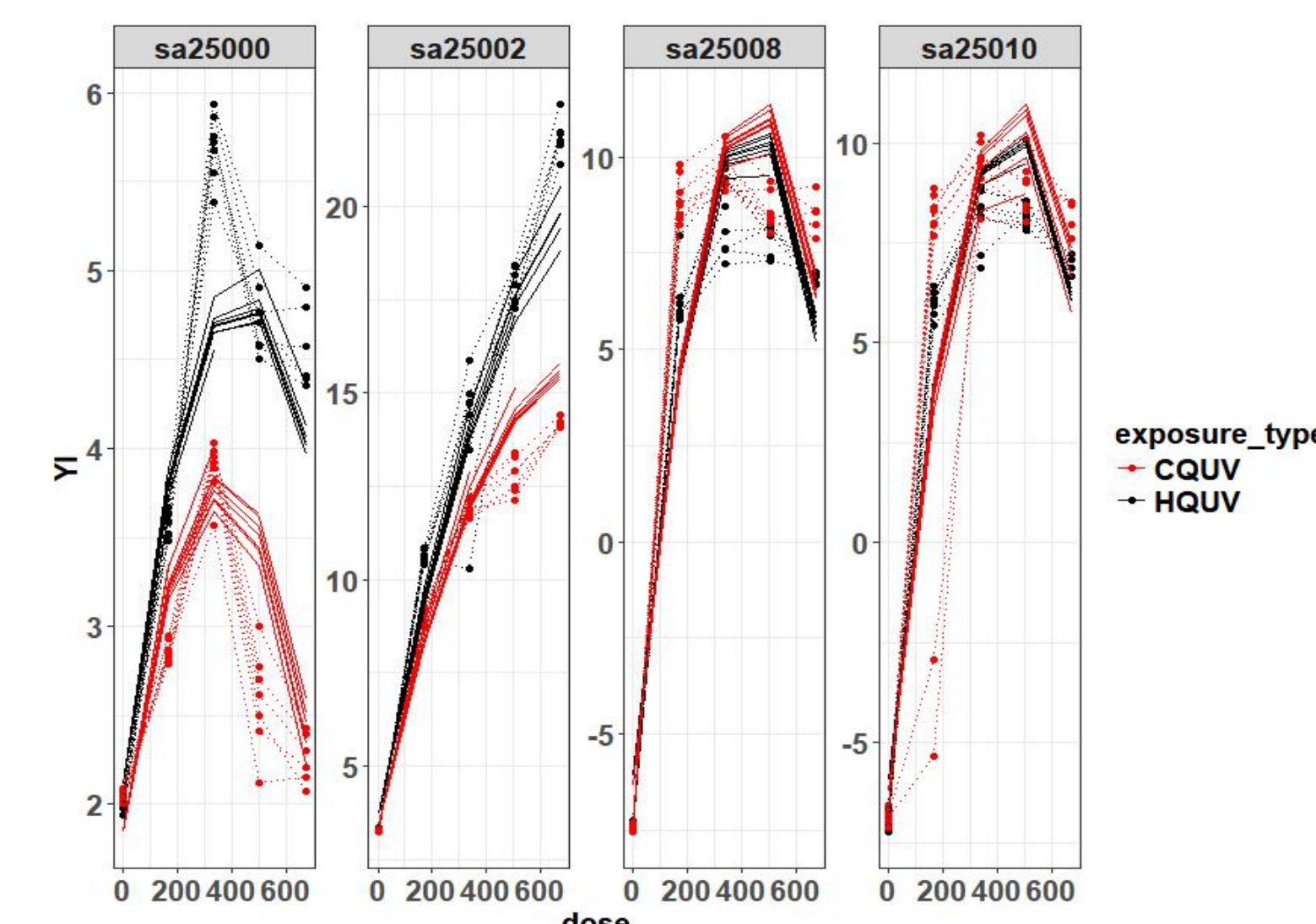
4.Deconvolution



5.Principle Component Analysis



6.Modeling methodology



Conclusion

1. FTIR data shows the degradation tendency of carbonyl group along with exposure
2. after baseline correction/ normalization/deconvolution, PCA analysis, the curves on the FTIR data are smooth, on the same baseline and easy to be quantitative.
3. Calculate peak ratio/full width at half maximum/integral of a Gaussian function in R. Those responses are very important to present the degradation tendency.
4. Peak ratio of carbonyl group and C-O group, as mechanism in semi-gSEM modeling, shows relative strong relationship with stress, which is time of illumination

Future Work

1. Use other general model to find correlation between predictors and response

References

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2. Bruckman, Laura S., et al. "Statistical and domain analytics applied to PV module lifetime and degradation science." *Access, IEEE* 1 (2013): 384-403.
3. Abdulkarim Gok, Laura S. Bruckman, et al. "Predictive models of poly(ethylene-terephthalate) film degradation under multi-factor accelerated weathering exposures."

Acknowledge

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