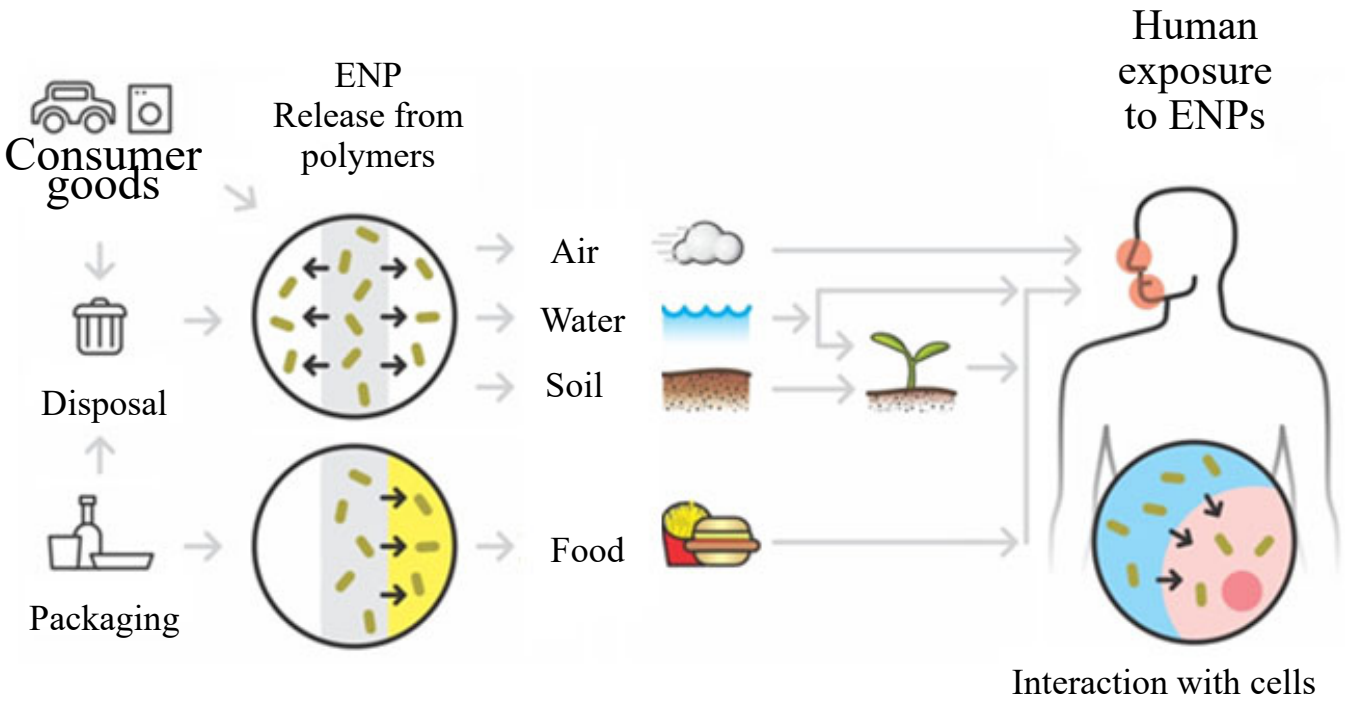
MICHIGAN STATE UNIVERSITY

The Fate of Nanoparticles in Food Packaging

Maria Rubino, PhD
Professor
School of Packaging
East Lansing, MI

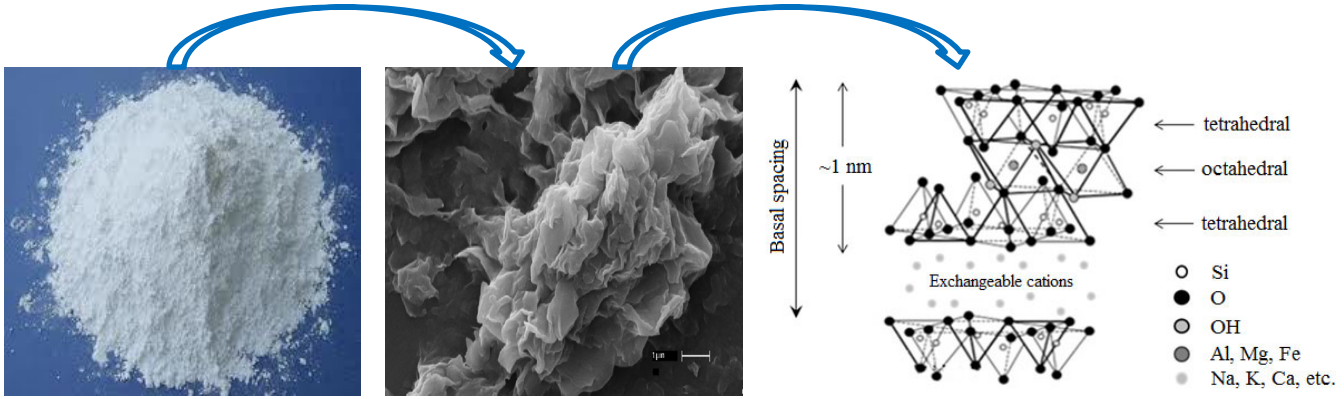
Public concerns

- Routes of human exposure to nanoparticle (from nanocomposites) → interaction with biological systems



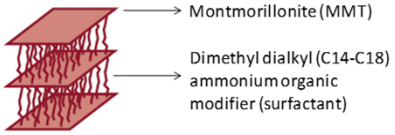
Nanoclay added in packaging

- Obtained from layered silicate minerals
- Common type: Montmorillonite (MMT)
- MMT structure: layered structure

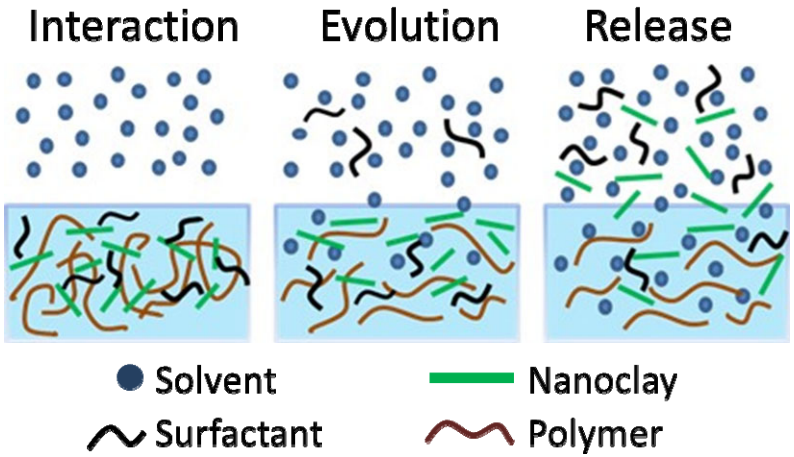


Images from www.google.com

Hypothesis

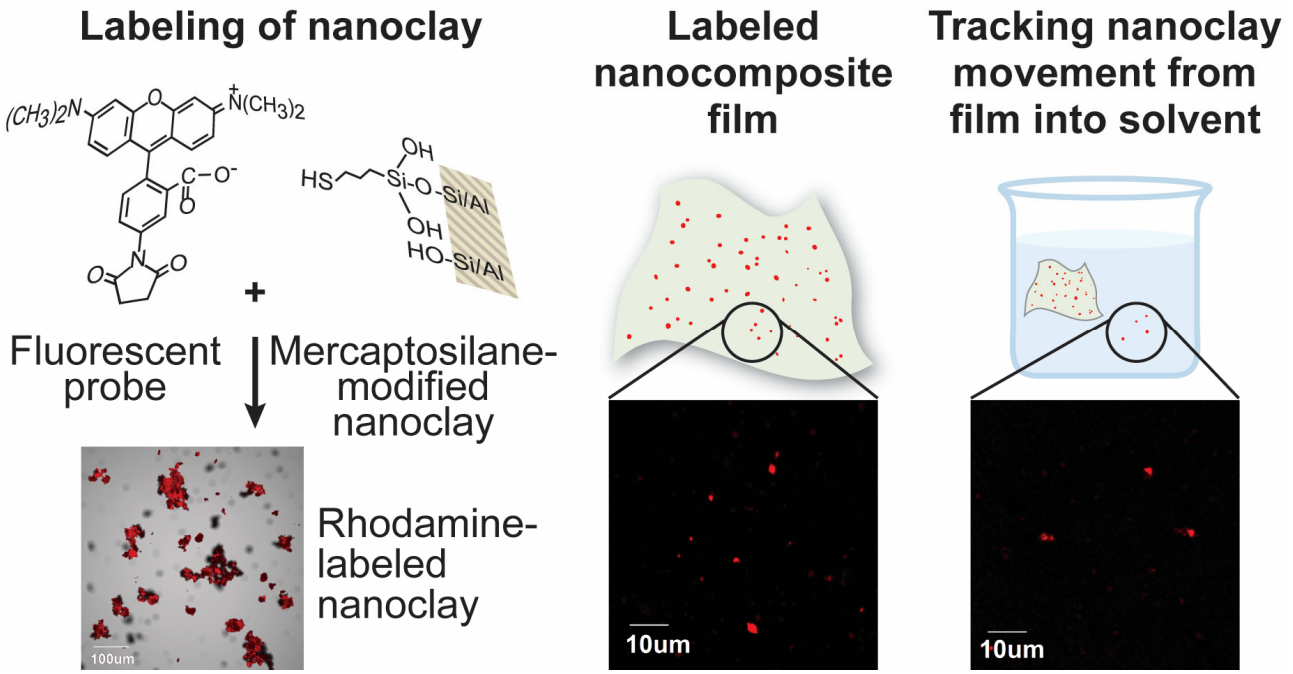


Structure of nanoclay



Fluorescent labeling and tracking of nanoclay

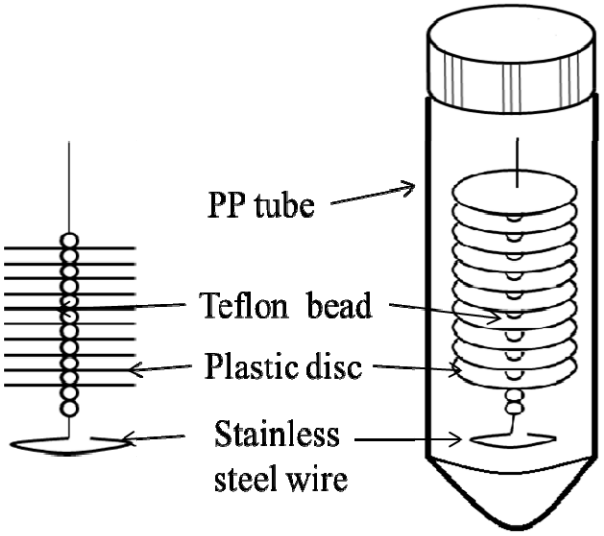
Diaz, Xia, Rubino, Auras, Jayaraman, Hotchkiss. Nanoscale 2013. 5:164-168



Experiment: release of **nanoclay**

ASTM D4754-11

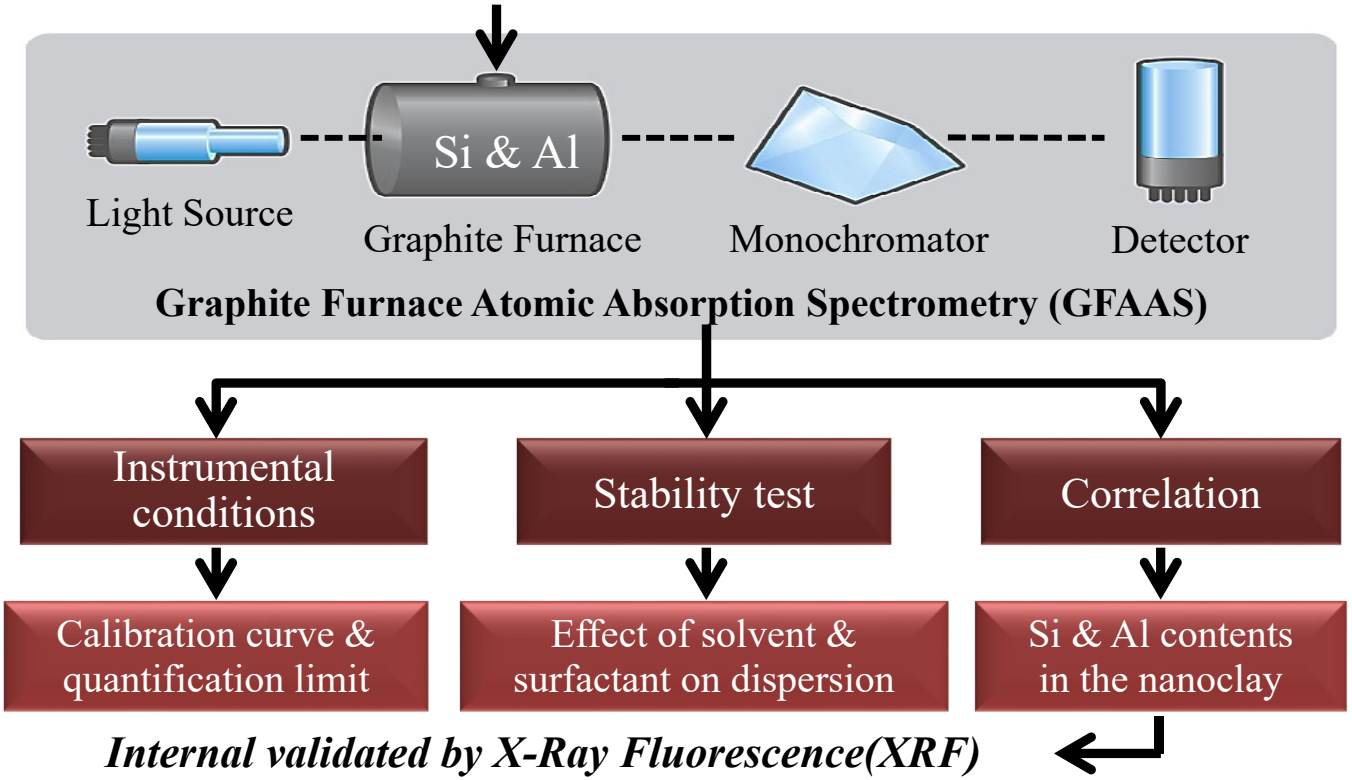
Film area: 100 cm^2
Simulant: ethanol
Solvent volume: 40 mL
Temperature: 22, 40, 70 ^oC
Migration cell: PP or glass
Multiple sampling points



Control samples applied:
Film without nanclay (assessment on nanoclay)

Instrumental analysis for Nanoclay

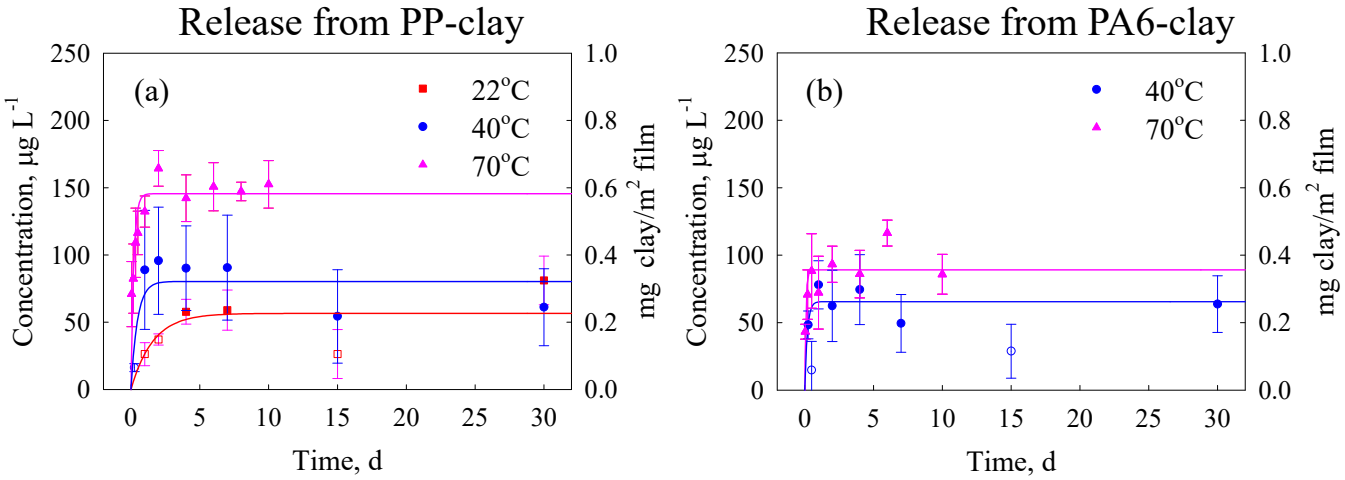
Xia Y, Rubino M, Auras R. 2013. Detection and quantification of montmorillonite nanoclay in water-ethanol solutions by graphite furnace atomic absorption spectrometry Food Addi. Cont. 30: 2177-2183.



Limit of quantification : 0.03 mg L^{-1} (Si) and 0.01 mg L^{-1} (Al)

Release of Nanoclay at 22, 40 & 70 °C

Xia Y, Rubino M, Auras R. 2014. *Release of Nanoclay and Surfactant from Polymer−Clay Nanocomposites into a Food Simulant*. Environ. Sci. Technol. 2014, 48, 13617−13624



- A small amount of nanoclay was released (0.1~0.2%)
- More nanoclay release from PP-clay than from PA6-clay
- Depending on the polymer-clay interaction

Experiment: release of **surfactant**

Xia Y., Rubino M, Auras R. 2016 Modeling of surfactant release from polymer-clay nanocomposites into ethanol Polymer Testing 60, 57-63

ASTM D4754-11

Film area: 100 cm^2
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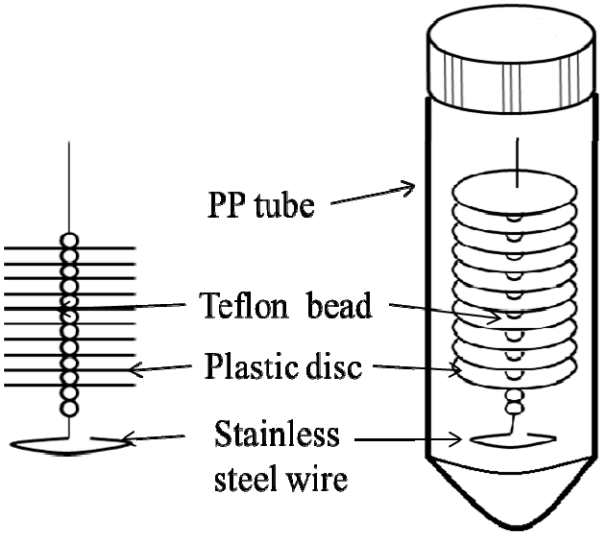
Temperature: 22, 40, 70 ^oC
Migration cell: PP or glass
Multiple sampling points

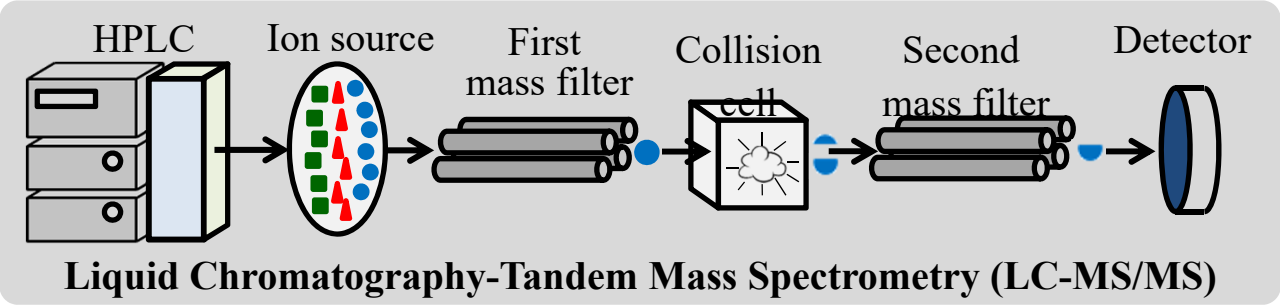


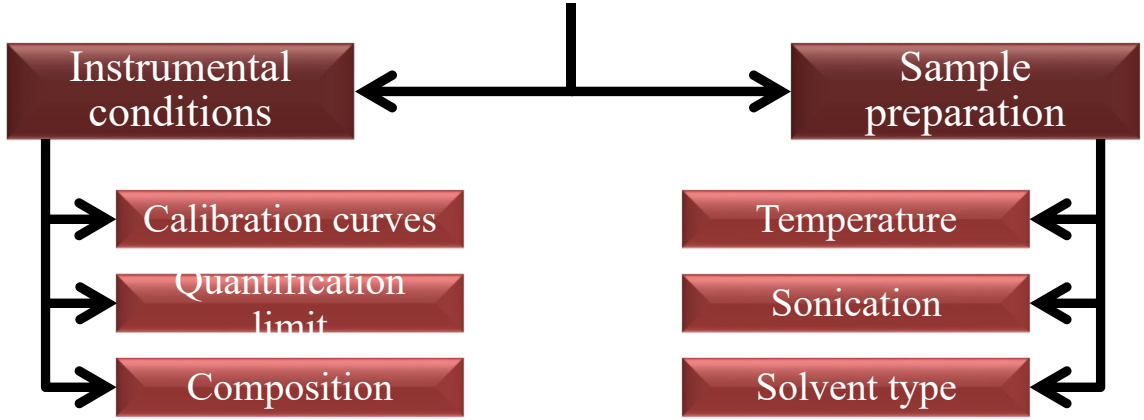
Control samples applied:

Film without nanoclay (assessment on nanoclay)

Instrumental analysis for surfactant

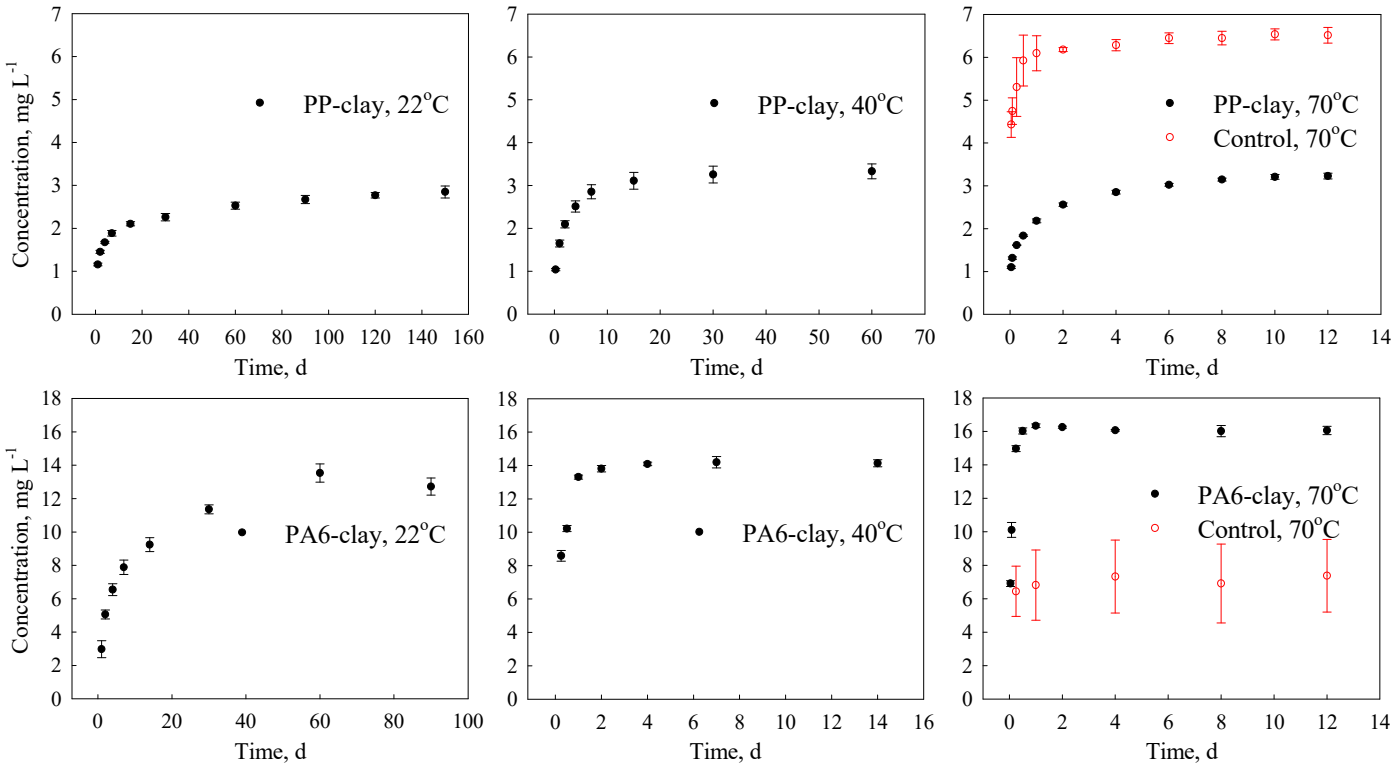
Xia Y, Rubino M, Auras R. 2015. *Release of surfactants from organo-modified montmorillonite into solvents: Implications for polymer nanocomposites*. Applied Clay Science 105-106 (2015) 107–112





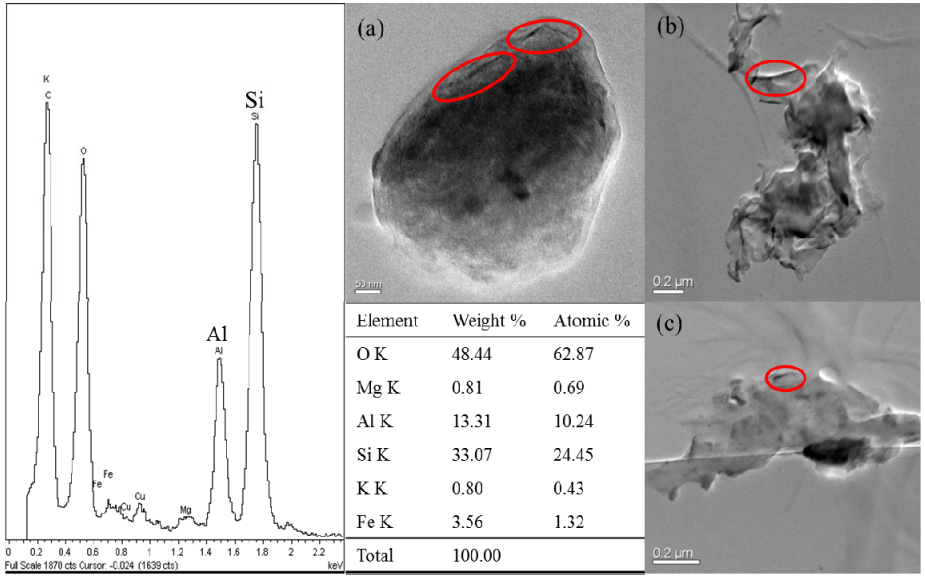
Release of surfactant at 22, 40 & 70 °C

Xia Y, Rubino M, Auras R. 2014. *Release of Nanoclay and Surfactant from Polymer−Clay Nanocomposites into a Food Simulant*. Environ. Sci. Technol. 2014, 48, 13617−13624



Further Assessment from the release study from nanocomposite:

Xia Y, Rubino M, Auras R. 2015. *Release of surfactants from organo-modified montmorillonite into solvents: Implications for polymer nanocomposites.* Applied Clay Science 105-106 (2015) 107–112



Element	Weight %	Atomic %
O K	48.44	62.87
Mg K	0.81	0.69
Al K	13.31	10.24
Si K	33.07	24.45
K K	0.80	0.43
Fe K	3.56	1.32
Total	100.00	

TEM images of released nanoclay particles from the PP−clay films and the corresponding EDS analysis for the particle in image (a). The structures (multiple parallel lines) shown within the circles exhibit a stack of clay layers. Scale bar: 50 nm for image a, 200 nm for images b and c.

Final comments:

1 Assessment of nanoparticles release requires:

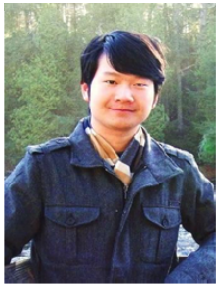
- Development and validation of new methodologies for assessing nanoparticles release from nanocomposite
- New ways to judge the results

2. It is very important to elucidate what is the **best approach** to **measure** nanoparticles interaction with polymers and how such interaction impact the release under different conditions **before** evaluating exposure and safety.

Team

Dr. Maria Rubino
Professor
Michigan State University

Dr. Rafael Auras
Associate Professor
Michigan State University



Dr. Yining Xia

Dr. Carlos Diaz

Dr. Jonas Alin

Acknowledgements