

DESIGN OF STIMULI-RESPONSIVE BIO-BASED MATERIALS FOR LACTOFERRIN (Lf) RELEASE

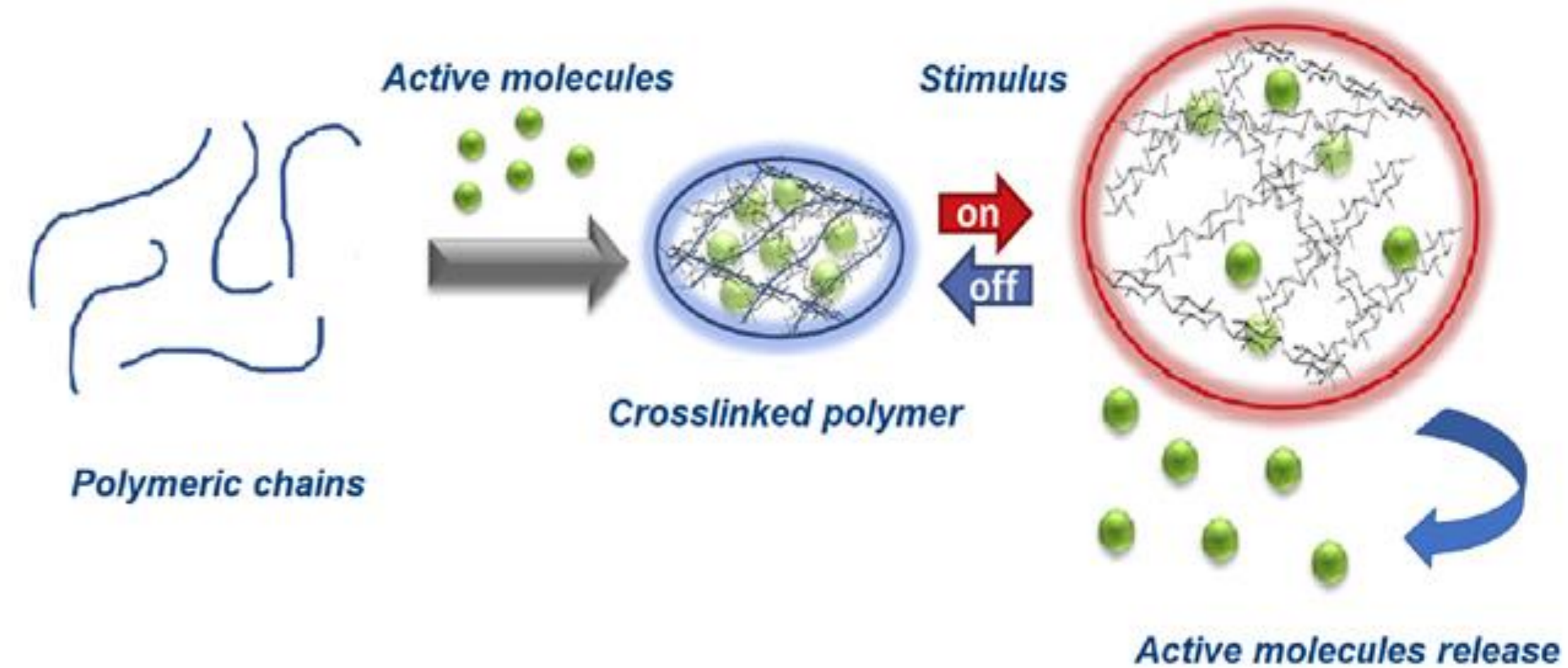
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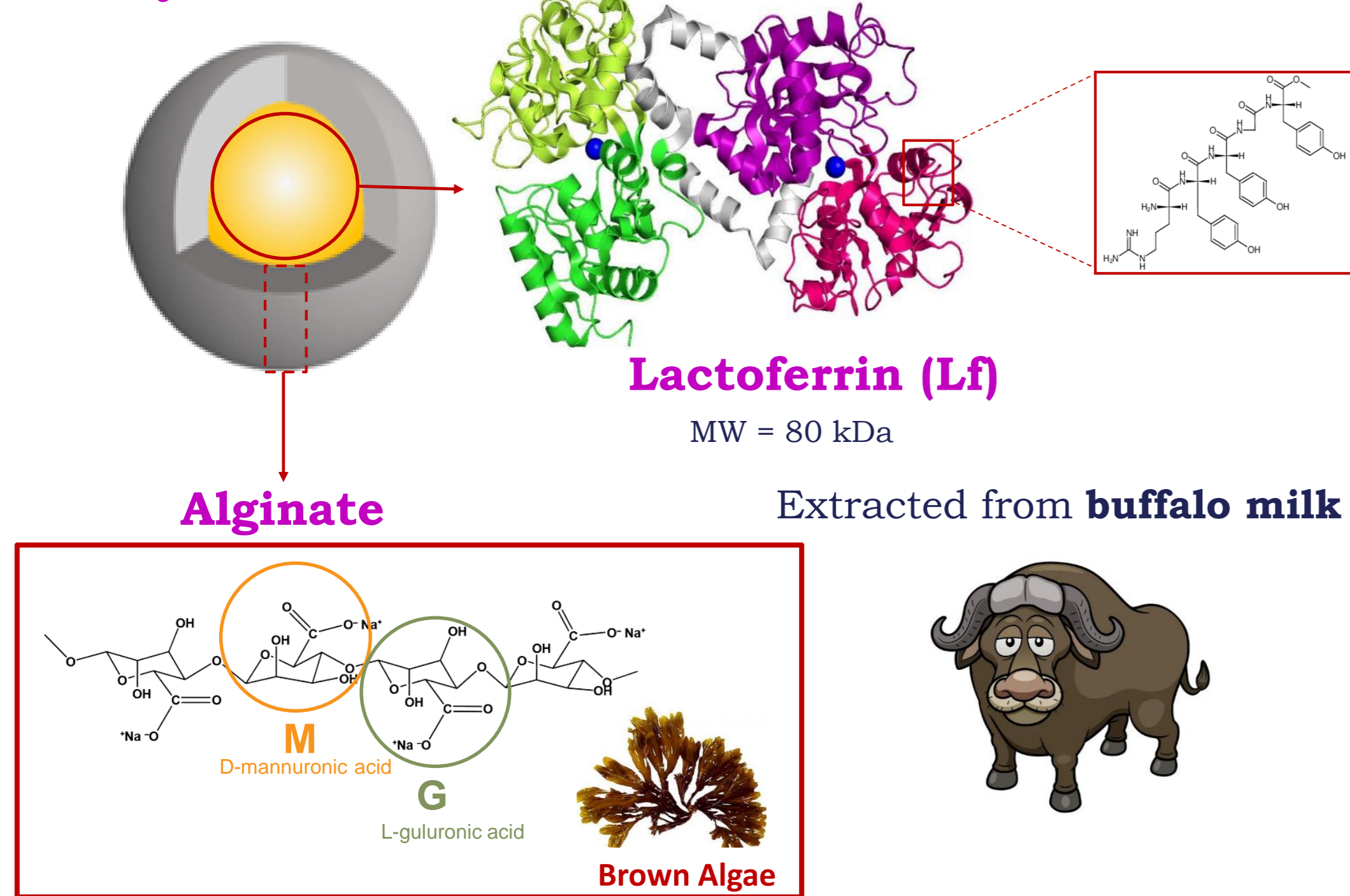
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Abstract

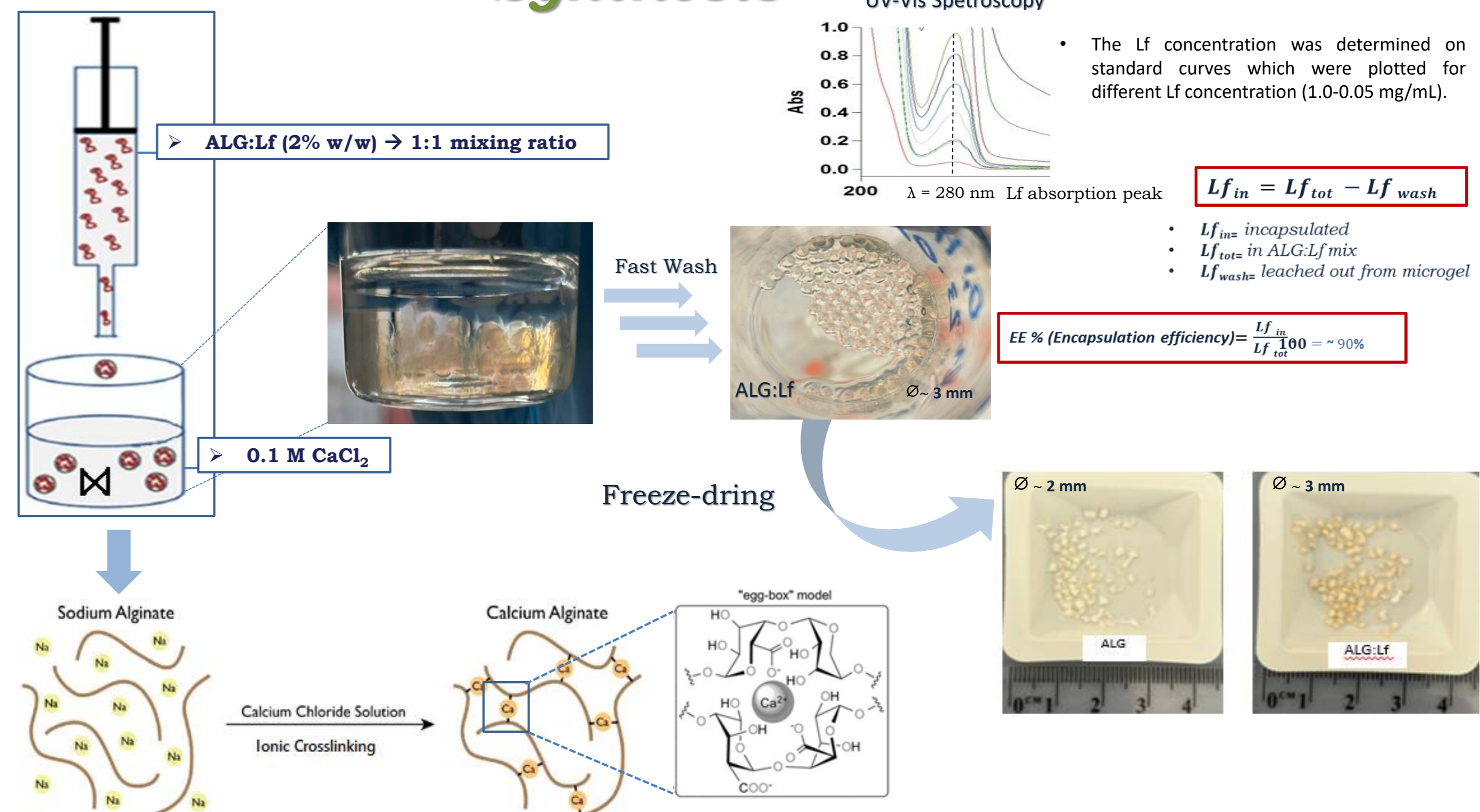
Bio-based polymeric stimuli-responsive materials are mainly composed of macromolecules with conformational and chemical changes in response to external signals. Lactoferrin (Lf), a milk glycoprotein, is one of the most attractive bioactive molecules due to its numerous beneficial effects on the human body (antimicrobial, anti-inflammatory, and anti-carcinogenic properties). A suitable strategy to enhance Lf stability and safe delivery is to encapsulate Lf in a matrix carrier system. Alginate is widely used due to its properties (biocompatibility, biodegradability, low cost) and its easily gelation by ionic crosslinking with bivalent cations. The Material optimization can be optimized using the Design of Experiment (DOE) a statistical approach to develop a mathematical Matlab model able to predict the Lf release over time.



Carrier system

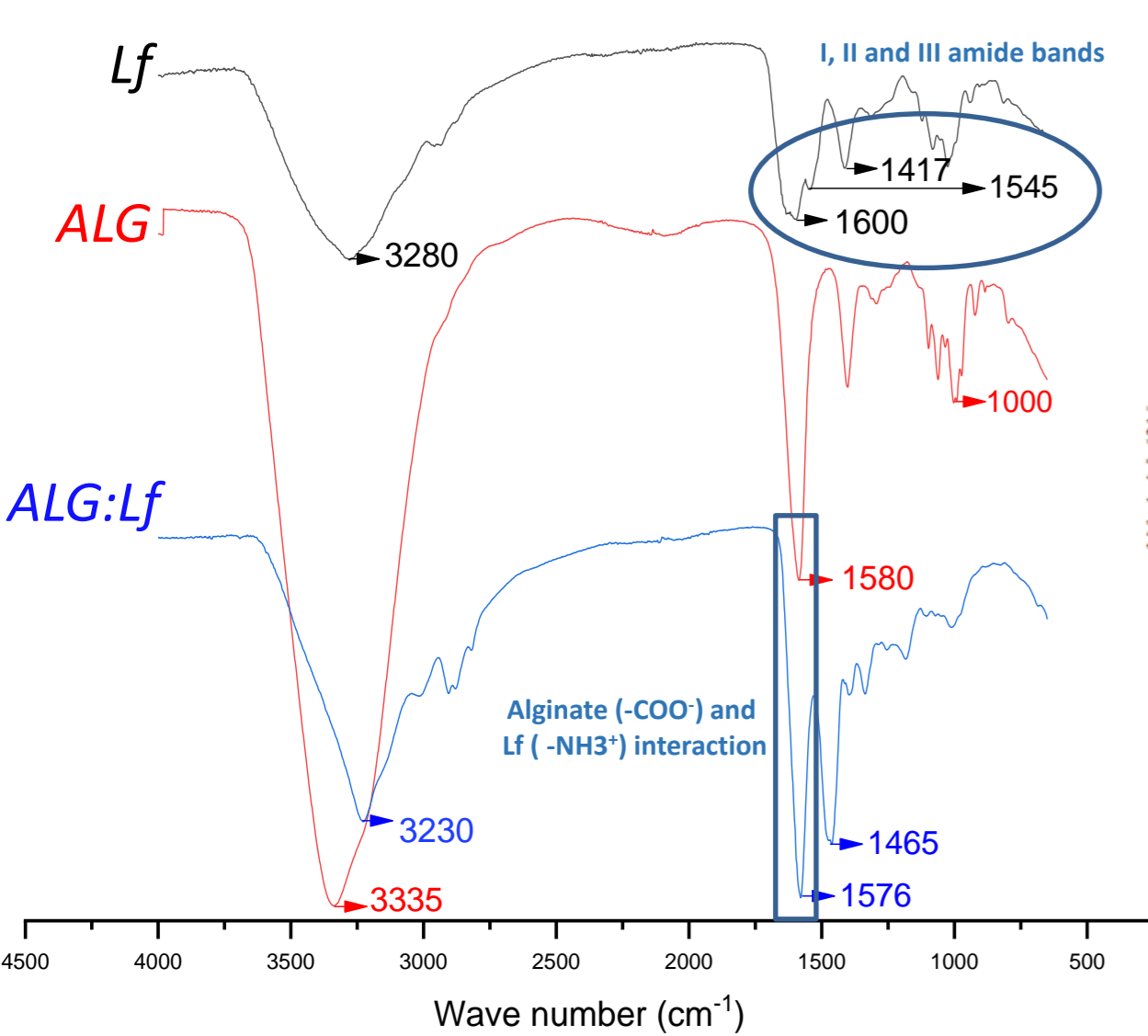


Synthesis

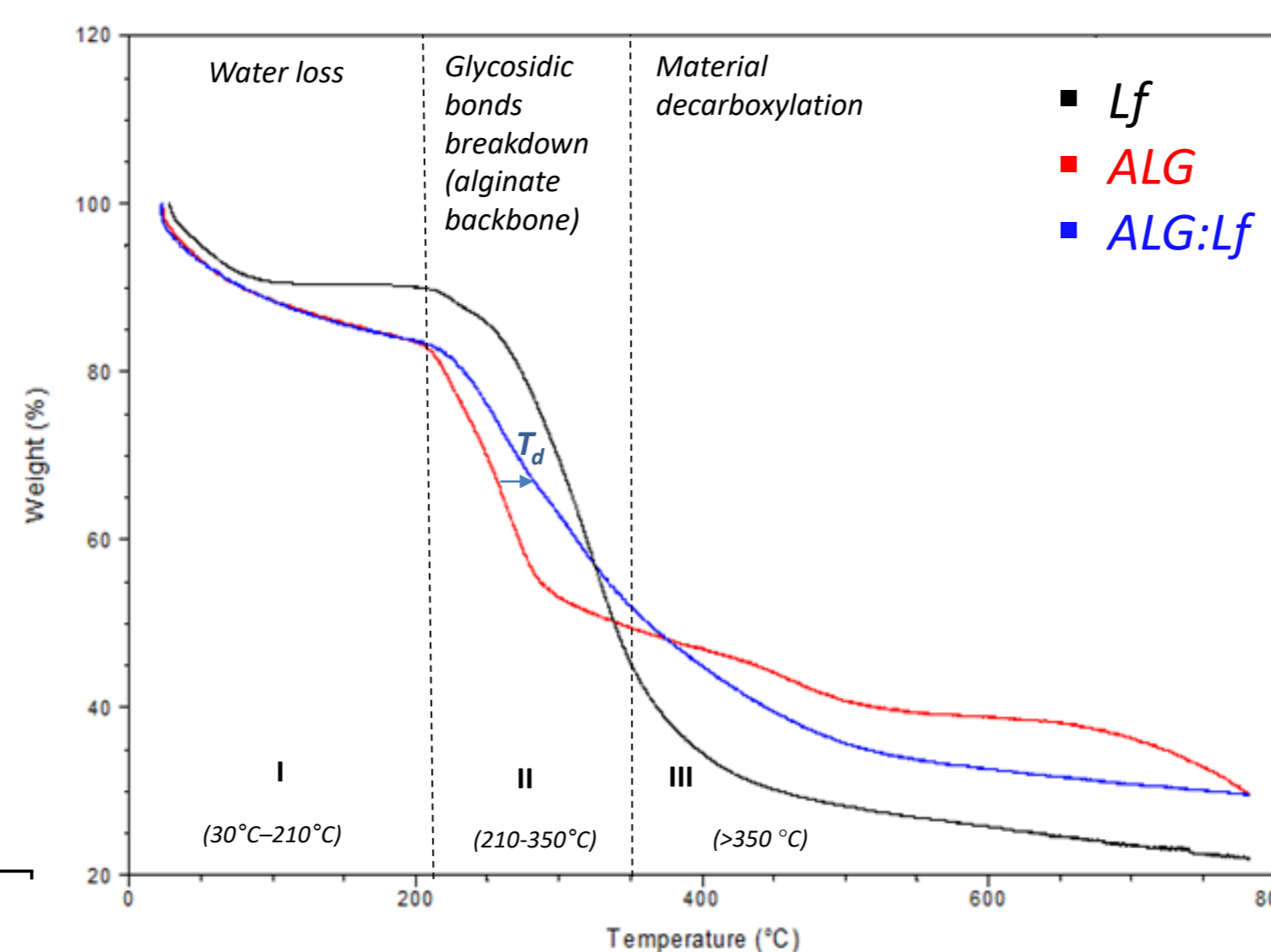


Characterization

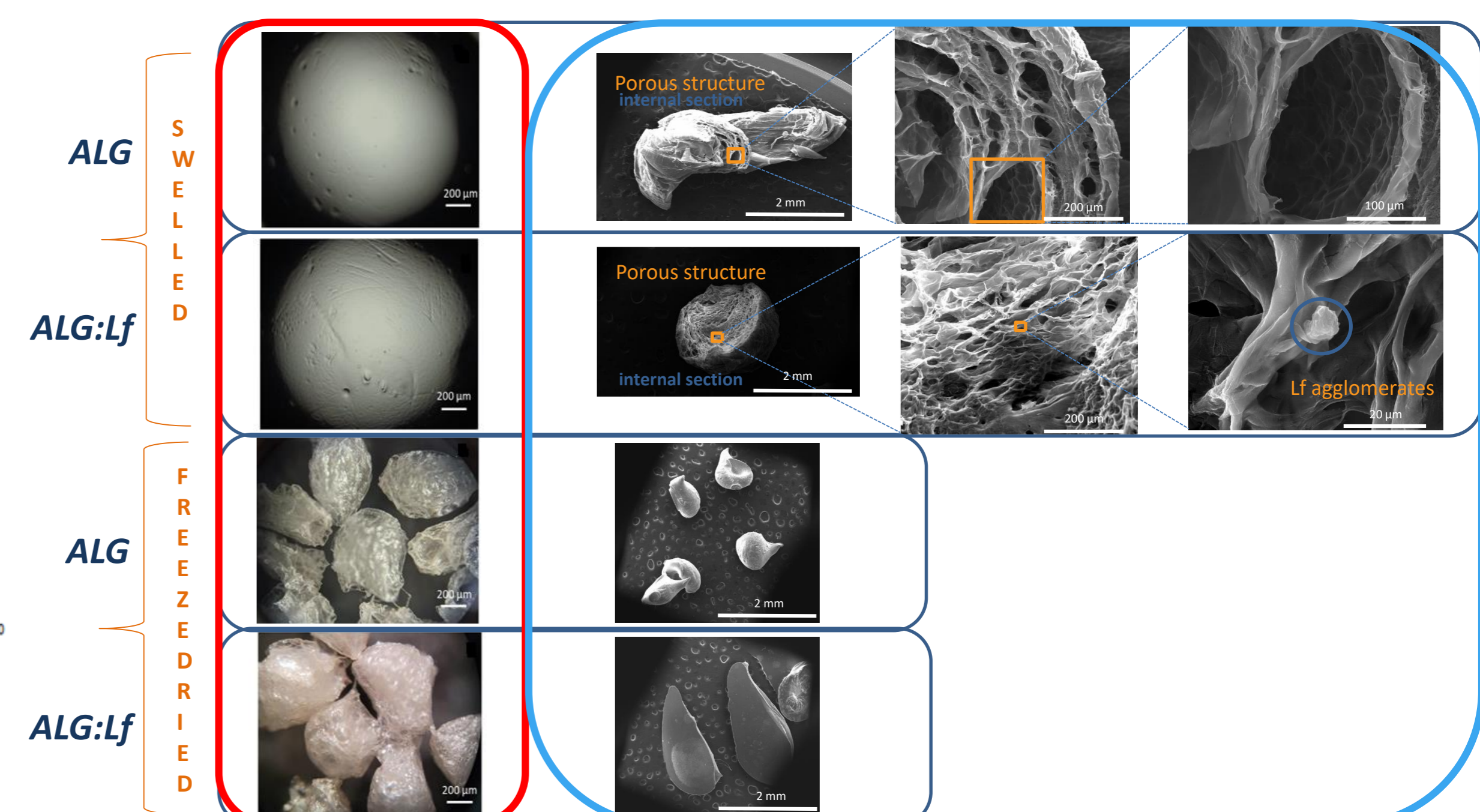
FT-IR spectroscopy



TGA (Thermogravimetric Analysis)

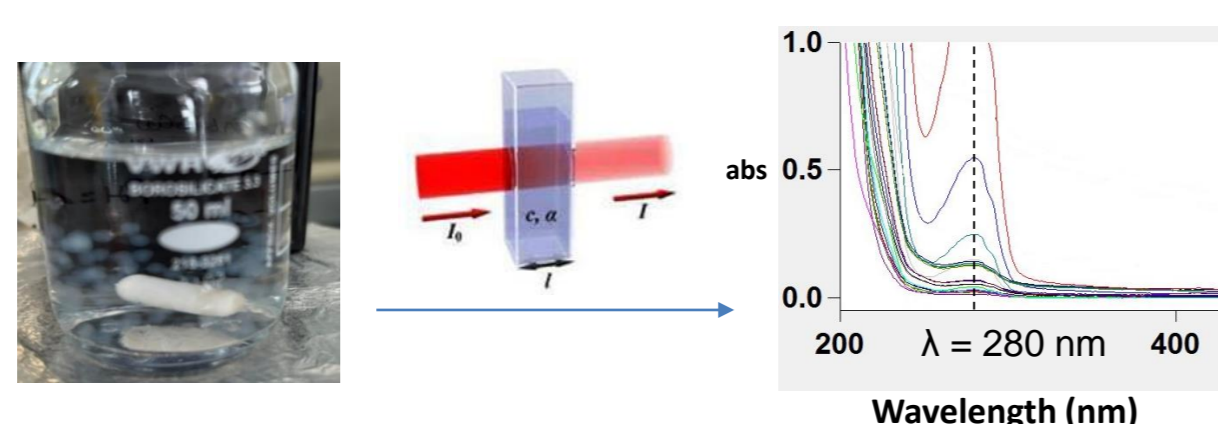


Optical Microscopy SEM (Electronic Scanning Microscopy)



Kinetic Study Release

In a typical experiment, particles are dispersed in aqueous solution under continuous stirring and Lf absorbance of the aliquot is measured on times.

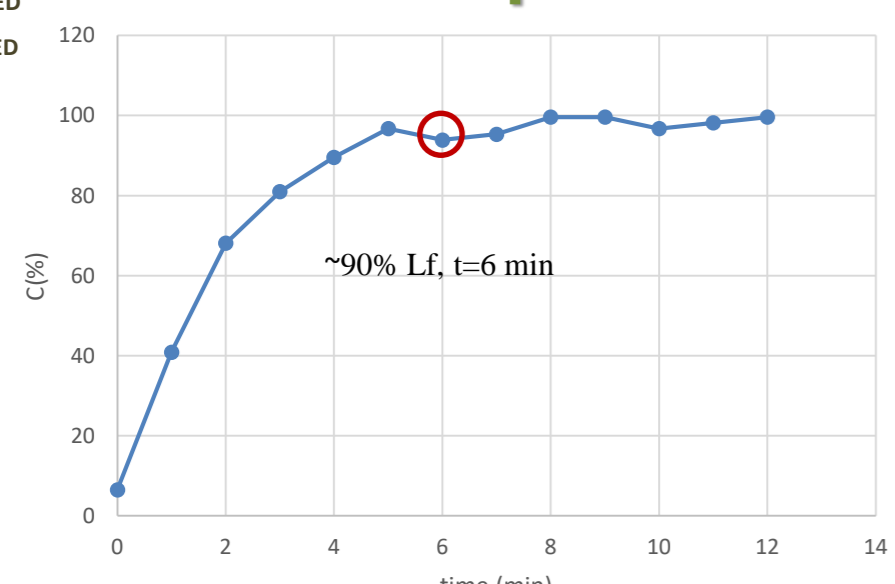


Different pH aqueous solution:

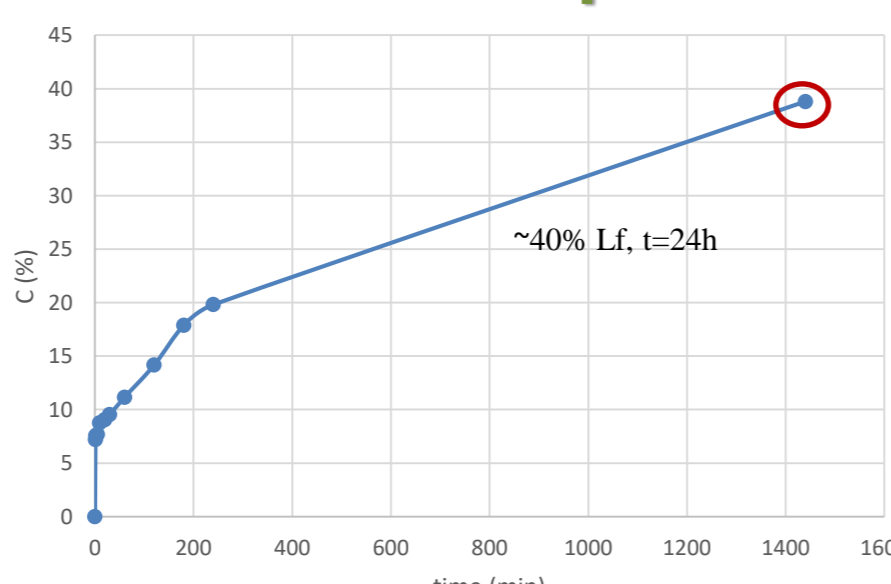
C (%) = mg Lf REAL / mg Lf ING (%)

C = Concentration
 $Lf_{REAL} = Lf_{REALIZED}$
 $Lf_{ING} = Lf_{INGLOBBED}$

Acid pH 5

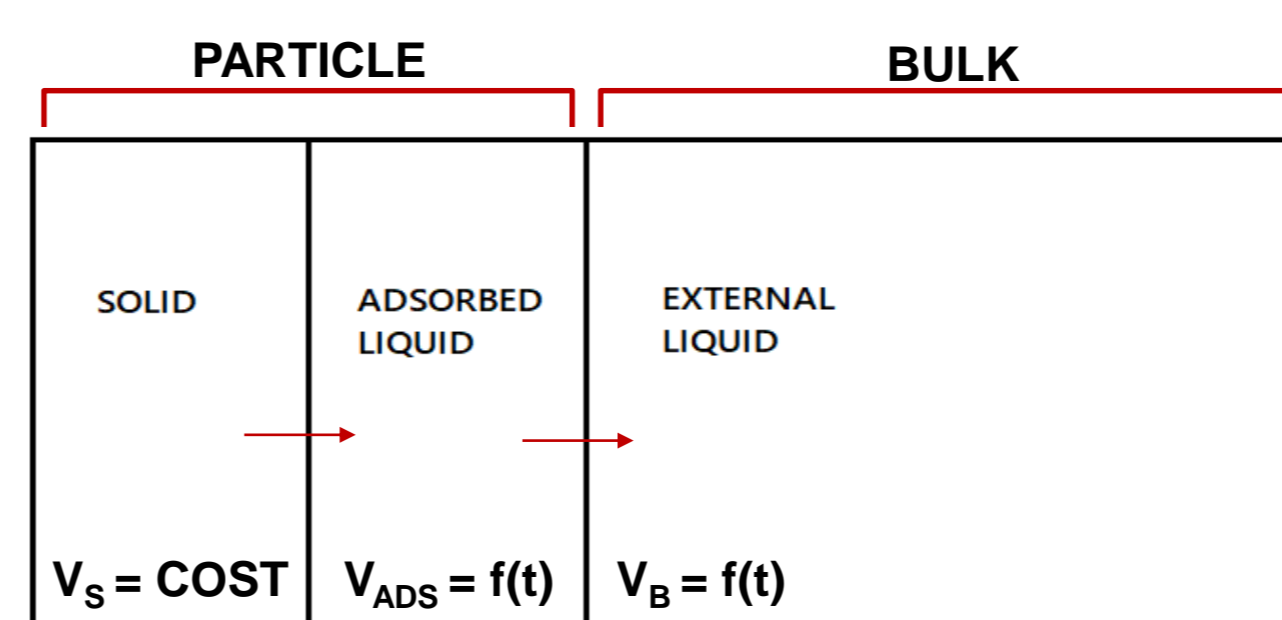


Neutral pH



Mathematic Release Model

The mathematical release model is a statistical model that allows to predict the percentage of active ingredient released over time. The freeze-dried particle is considered as a dry solid with a swelling volume that varies over time, described by Kv (swelling constant from a previous MATLAB mathematical model). At zero time, the dry solid already contains several Lf moles (n_{SL}) which are gradually released within the liquid phase adsorbed by the particle and subsequently released to the external liquid bulk in contact with the particle.



- V_S = Solid volume
- V_{Ads} = Adsorption volume
- V_B = Bulk volume
- V_{Max} = Maximum particle volume
- K_v = Swelling Constant
- J = Transport flow
- β = Mass transfer diffusivity
- H = Distribution equilibrium constant

Volume Balance

$$\frac{dV_{Ads}}{dt} = +K_v(V_{Max} - V_{Ads})$$

$$\frac{dV_B}{dt} = -K_v(V_{Max} - V_{Ads})$$

Transport flows

$$J_{SL} = \beta_{SL} \left(\frac{C_{SL}}{H_{Lf}} - C_{Ads_{Lf}} \right)$$

$$J_{LL} = \beta_{LL} (C_{Ads_{Lf}} - C_{B_{Lf}})$$

Moles Balance

$$\frac{dn_{SL}}{dt} = -J_{SL}V_{Ads}$$

$$\frac{dn_{Ads_{Lf}}}{dt} = +J_{SL}V_{Ads} - J_{LL}V_{Ads}$$

$$\frac{dn_{B_{Lf}}}{dt} = +J_{LL}V_{Ads}$$