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Biodiversity and Cosmetics: Reaching Sustainable Technology

# Drying behaviour of polymer films


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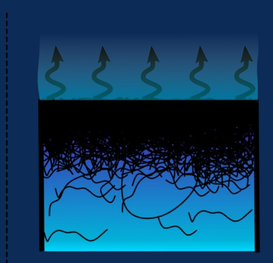
## Introduction

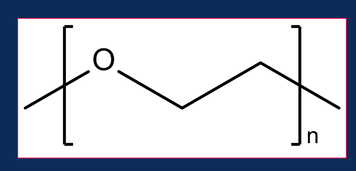
Various cosmetic and personal care products exhibit film-forming properties upon drying, such as sunscreens, lip gloss and nail varnish.

Film formation occurs as the solvent evaporates from a polymeric solution and leaves a “skin” of polymer on the surface. Understanding the internal dynamics and processes during film formation enables the formulator to predict the behaviour and properties as a formulation is altered.

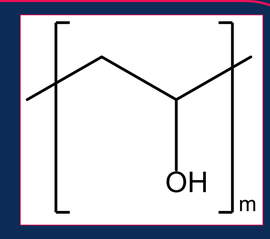


## Method

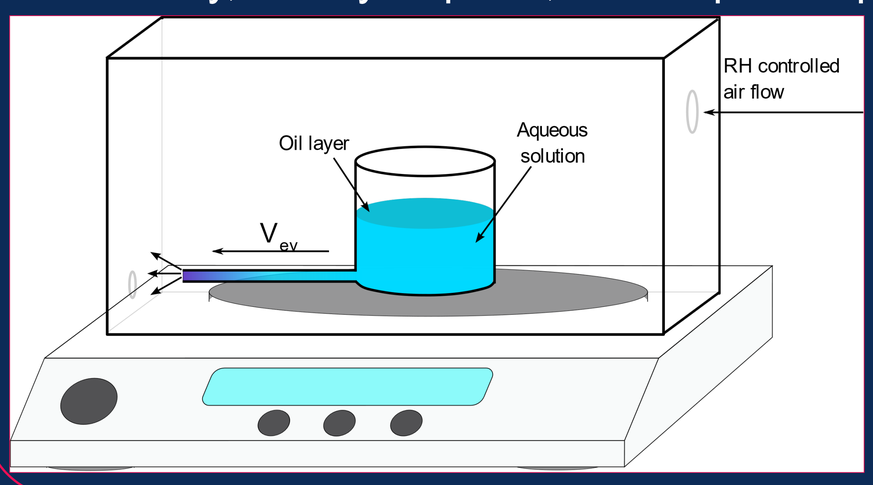
In this study, two hydrophilic, biocompatible polymers were used as model polymers:




***Polyethylene Glycol (PEG)***



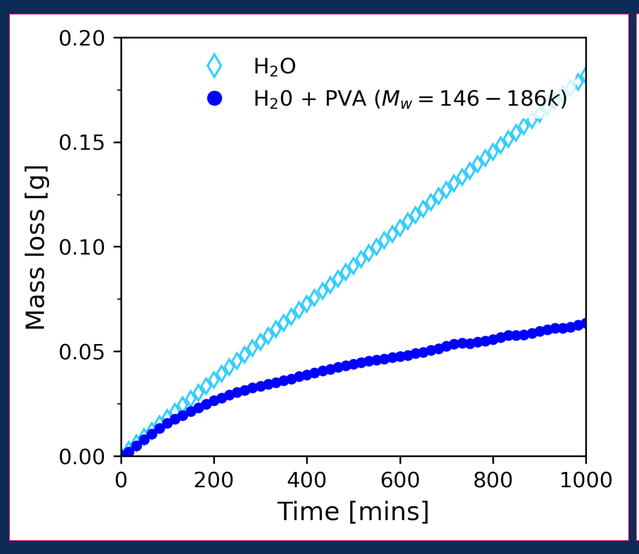

***Polyvinyl Alcohol (PVA)***

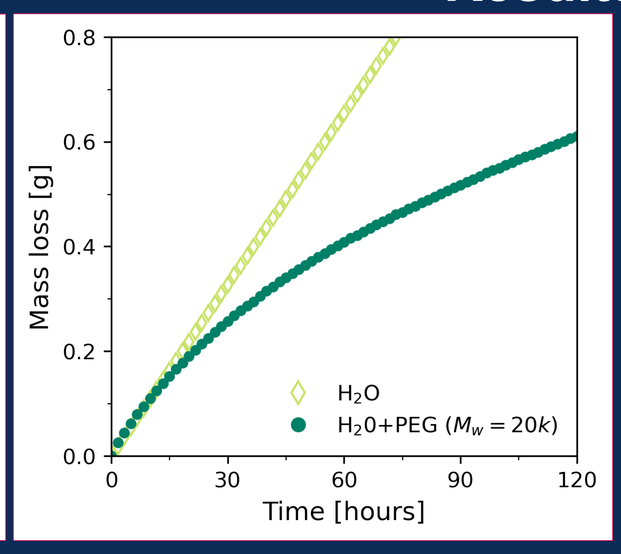



A setup to measure mass loss by water evaporation from capillaries was developed, using a high-precision scale in a sealed enclosure with controlled relative humidity and temperature.

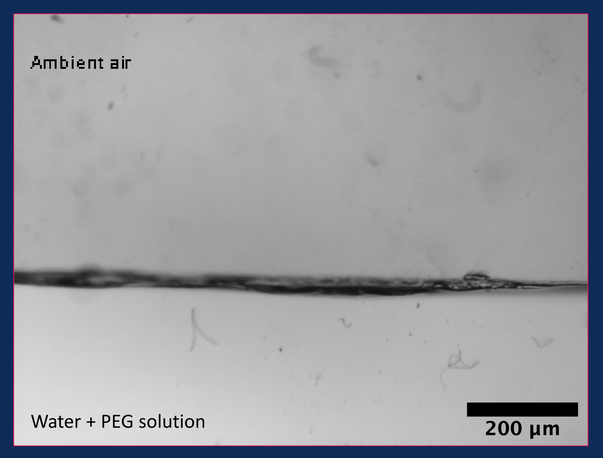
2 mL of the polymer solution was placed in the vessel and covered with a thin layer of 1-Octadecene.

## Results




The evaporation rate of water is constant whereas the evaporation of water from a 1 % polymer solution is not, *e.g.* PVA (left) and PEG (right).


In the PVA solution (left), polymer layers increase the compressive stresses in the system leading to buckling of the solution away from the sides of the capillary.

In the PEG solution (right), no buckling observed at the interface due to differences in the stress build-up in the polymer layers near the interface.

## Conclusions

In this work, a system was developed to measure accurately and repeatedly changes in evaporation behaviour.

- For a polymer solution, the polymer impacts the drying rate of the solvent.
- As water evaporates, a film is formed at the air-water interface reducing the transport of water to the surface.
- Understanding the behaviour of polymer solutions provides useful information on how cosmetic ingredients are affected by manufacturing changes as well as how the end-product behaves.
- This experimental setup can be used to study more complex systems used in cosmetics *e.g.* polymer in surfactant solutions, and microgel dispersions.

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