



Universität Stuttgart



# Foam-Based Cleaning of Historical Surfaces

Institute of Physical Chemistry

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# Introduction



The historical surfaces of artistic and cultural assets are often soiled as a result of long-term exposure to environmental influences.

→ Cleaning these objects is a great challenge as each surface requires a tailor-made cleaning method to remove dirt without damaging the artwork.

**Purpose:** clean the historic carriages of kings and emperors of past centuries in the Marstallmuseum at Nymphenburg Palace in cooperation with the “Bavarian Administration of State Palaces, Gardens and Lakes”.

We were able to reveal that foams have great potential as suitable cleaning agents. Our goal is to develop **new, innovative foam-based cleaning methods.**

# Introduction

## Reasons:

- ◆ reduction of amount of detergent by up to 90 %
- ◆ application on hard-to-access surface shapes
- ◆ gentle removal by vacuuming

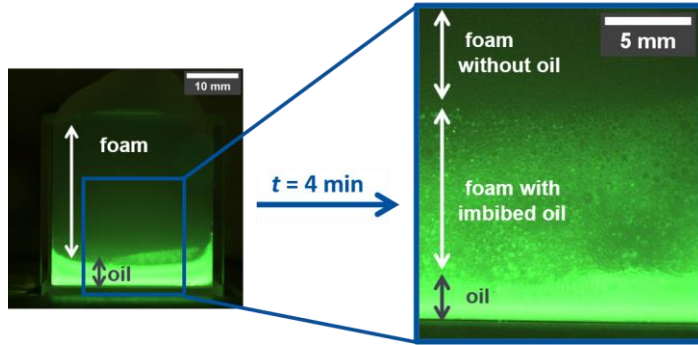


optimized with foams with the  
**“right instability”**



# Physical Cleaning Mechanisms

## Mechanism I - Imbibition



Studying imbibition in the foam: The foam is applied to fluorescent oil (left). Over time, the oil is sucked into the plateau borders of the foam (right) [1,2,3].

### Required conditions:

- ◆ small bubble sizes
- ◆ low liquid fractions

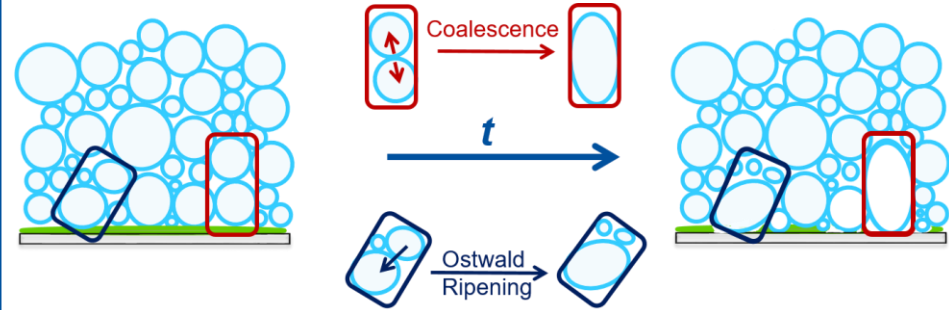
➔ “sponge-effect”

[1] T. Schad *et al.*, *Journal of Colloid and Interface Science*, **2021**, 590, 311–320.

[2] T. Schad *et al.*, *Nachrichten aus der Chemie, GDCH*, **2021**.

[3] T. Schad *et al.*, *J Surfact Deterg.* **2022**; 25:377–385.

## Mechanism II - Wiping



Schematic drawing of the wiping activity of the bubbles caused by Ostwald ripening and coalescence and subsequent rearranging of the bubbles [1,2,3].

### Driving force:

instability of liquid foams

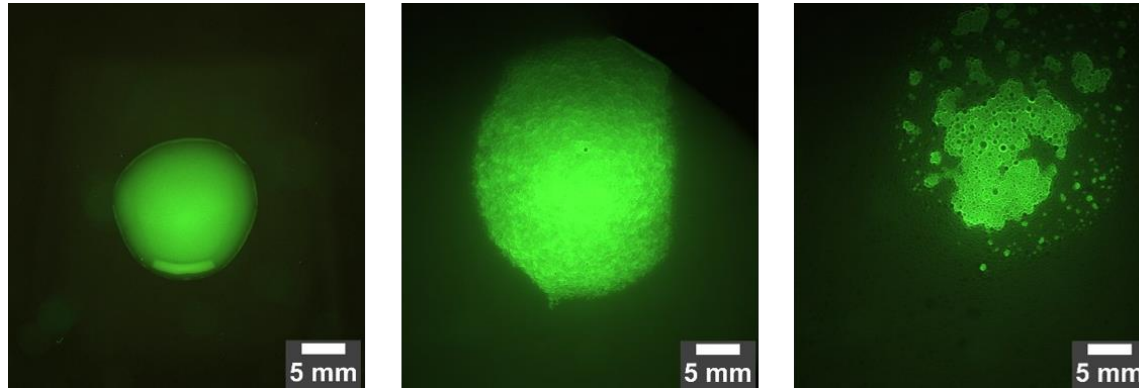
→ bubbles pop and move around

➔ “bubble-wipe”

# Optimum Cleaning Foam Properties

Optimum cleaning effect: **“right instability”**

- sufficiently stable to maintain “sponge-effect”
- sufficiently unstable to ensure an optimal “bubble-wipe”



Photographs of a cleaning test (left) before applying the cleaning foam to the model soiling, (middle) after applying the foam and (right) after the exposure time of  $t = 15$  min and before removing the foam [1].



**Combination of Imbibition & Wiping is most efficient [1]**

No additional mechanical action is needed: **Less is More!**

→ Simply let the foam sit on the surface for a while before removing it by vacuuming.

# Cleaning Tests on Real Historical Objects

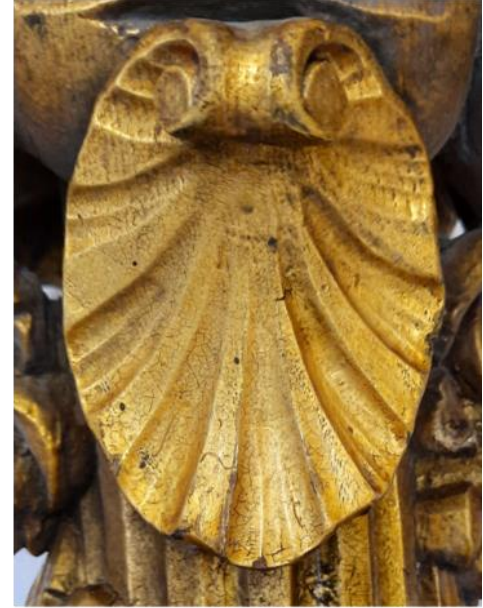
Historic wooden carved and gold-plated shell on the drawbar of the Renaissance sleigh of King Ludwig II of Bavaria



before cleaning



during cleaning with foam



after cleaning

# Conclusion

Historic carved and gilded dolphin on the crowning carriage of king Karl VII



- ✓ successful cleaning result
- ✓ no additional mechanical action
- ✓ cleaning of rough and vertical surfaces



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