

# Smart Colour Textiles

The SmartColourTextiles DemoKit was developed as learning by doing tool to give interested companies and persons the opportunity to learn more about the smart textiles technology by their own. The technology is based on indicator dyes that change their colour upon interaction with specific analytes. These dyes are immobilized to textiles and non-wovens opening new applications in the field of clothing, healthcare, ambient assisted living and sports. For many applications, it is possible to integrate the technology directly into existing textile fabrication processes.

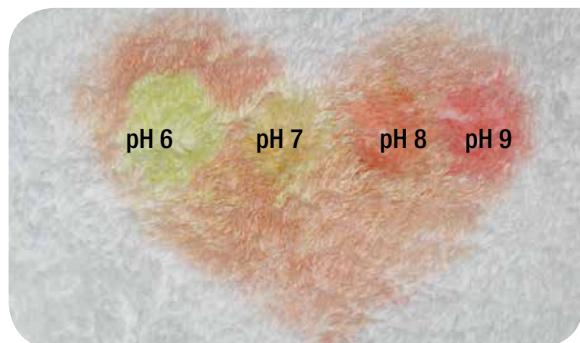


## Advantages

- Colour changes
- Easy to understand
- High flexibility
- Can be washed and ironed
- Fully reversible
- Compatible to textile fabrication

## Applications

### Indicator washcloth



Colour comparison with pH: pH 6 pH 7 pH 8 pH 9

### Background

The acid mantle of the skin has a pH of about 5.5, which is slightly acidic. This protects the skin against bacteria, fungi and dryness. Therefore, skin-friendly (so-called pH skin-neutral) detergents, shampoos and shower gels have a slightly acidic pH. Soaps and low-cost cleaning products however, are often alkaline (pH above 8), which can lead to skin irritation in both infants and dermatitis patients.

### Idea

An indicator washcloth is stained with a pH indicator. This indicator shows a colour change from green to red depending on the pH of the washing solution. Green signifies that the pH value is below 7 and is in the skin-friendly pH range, while red means that the pH is above 8, indicating that skin irritation may occur.

### Instructions for use

The washcloth is designed exclusively for cleaning products used in personal care. The washcloth may be immersed into the cleaning solution (e.g. in the bathtub), or used directly during a shower. One may also test cleaning products prior to use by mixing a few drops of detergent with a little bit of water and then dipping the washcloth into the solution. The indicator washcloth only shows the pH value correctly when the measuring area (the coloured heart) is significantly wet. Before reusing the washcloth, it should be rinsed several times with tap water to remove any traces of the previous cleaning product. In order to estimate the pH accurately, a colour comparison chart can be used. The washcloth should be washed at a maximum of 60 °C and with white textiles only. Since the dye is sensitive to UV light, the washcloth should not be exposed to direct sunlight.

### Additional information

If, after washing in a washing machine, the damp washcloth is red, there are still detergent residues in the textile and purging using a washing machine was not sufficient. The safety of the staining with the indicator dye was certified by OekoTex.

## Sensor Swabs for Monitoring pH in Wounds



Principle of optical pH measurement in chronic wounds

### Introduction

Chronic wounds are a painful problem for the elderly people and diabetics. Recent research has shown that the pH of the fluid in wounds correlates with the healing process. A pH above 8 indicates that medication is necessary, since for efficient healing, the pH should be in the range of 5 to 7.

### Colour change and sensitive range of indicator cotton swabs

Currently, wound pH measurement involves collecting a sample of the liquid in the wound and taking it for analysis. However, in order to enable faster, less expensive and simpler information gathering of the wound status, sensor cotton swabs have been developed. Swabs are normally used for cleaning the wound, but here, they are covalently functionalised with a pH indicator dye. The indicator cotton swabs (ICS) show a clearly visible colour change from green (ideal pH) to red (treatment necessary). This colour change can be interpreted by the naked eye as well as by an optical colour measurement device in order to obtain quantitative data based on the CIE L\*a\*b\* colour space.

Two types of swabs were developed; indicator cotton swabs ICS1 with a sensitive range from pH 5 to 7 and swabs ICS2 with a sensitive range from 6.5 to 8.5. The swabs were gamma-sterilised and the effect of sterilisation on performance was found to be negligible. Furthermore, cytotoxicity testing

showed cell viability and endotoxin levels to be within the allowed range. A preclinical pilot study of the swabs will take place once approval by the ethics committee is granted.

### Cytotoxicity testing

- Reaction of MRC-5 cells (Dehydrogenase activity) using elutes of the swabs, Duration 24 h, analogue to ISO 10993-5:
  - Commercial sterile swabs: cell viability 94%
  - ICS1: cell viability 75%
  - ICS2: cell viability 89%
  - Threshold: >70% cell viability
- Direct contact with indicator cotton swabs does not cause any decrease in cell density

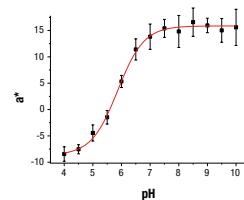
Endotoxin-Test (Proenzyme activation in Limulus Amebocyte Lysate: < 5 EU/item found – threshold is 20 EU/item)



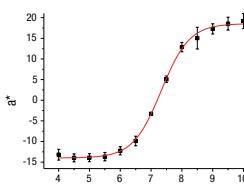
Colour change of ICS1



Colour change of ICS2



pH calibration of ICS1 (n=5)



pH calibration of ICS2 (n=5)

	ICS1 (not sterile)	ICS1 (sterile)	ICS2 (not sterile)	ICS2 (sterile)
Five different swabs calibrated once	5.89 (0.07)	5.85 (0.06)	7.38 (0.11)	7.34 (0.05)
One swab calibrated five times	5.75 (0.11)	5.87 (0.07)	7.38 (0.09)	7.37 (0.03)

Table 1: pKs evaluation of the indicator cotton swabs (ICS) before and after sterilisation (standard deviation in brackets)



## Indicator label

A smart label for clothing is capable of telling not only at what temperature to wash and iron the textile but also whether the textile can cause irritations or allergic reactions. The indicator on the label will change its colour when irritant (alkaline) washing agents are still present in the textile, because then, the label will turn red. Only when the textile has been sufficiently rinsed with water and all washing agent removed, will the label turn green. Residues of washing agents are typically observed when excess amounts of washing agents are used, or when washing machines are not rinsing the textiles properly. Thus, such indicator labels may be relevant not only for babies or elderly people with sensitive skin, but for anybody who wishes to take care of their skin.

Currently, we develop new indicator dyes for sodium, potassium or magnesium ions for sweat analysis, as well as quaternary ammonium ions used for sterilisation. Furthermore, we also work on indicators for amines, sulphides, and cyanide. And we plan to expand our range of dyes to fluorescent indicators for analyte sensing.



## Indicator cotton glove

To provide safety at work and a healthy working environment, it is essential to be informed about any possible contact with toxic and caustic chemicals. Strong acids and bases, for example, are colourless and highly viscous fluids and can be vitriolic in minute amounts on the skin. Sulphuric acid for example causes thermal and chemical burns leading to deep-tissue injuries on the skin, and alkali solutions cause severe skin and eye irritations.

The indicator cotton glove has two indicator dyes immobilised simultaneously, one sensitive to acids and one to bases, enabling the detection of strong acids and bases with the same textile. The colour change from orange to purple-red is observed in both cases. When the presence of strong acids and bases is recognised immediately, contamination of other surfaces or contact with other people can be avoided. Such sensing chemistries can be integrated into laboratory coats or protective clothing of first responders. In the future, this technology may also be applied to the sensing of toxic gases and specific chemical reagents.

## CONTACT

JOANNEUM RESEARCH  
Forschungsgesellschaft mbH

Institute for  
Surface Technologies  
and Photonics

**Gerhard Mohr**

Franz-Pichler-Strasse 30  
8160 Weiz, Austria

Phone +43 316 876-34 04  
Fax +43 316 8769-34 04

gerhard.mohr@joanneum.at  
materials@joanneum.at  
www.joanneum.at/materials

### This Smart Colour Textiles Demokit includes:

- two indicator washcloths
- ten indicator cotton swabs type 1 (sterilised)
- ten indicator cotton swabs type 2 (sterilised)
- ten indicator labels
- two indicator gloves
- two aerosol cans, one with citric acid, one with potassium carbonate
- one beauty soap and one liquid soap

*This work was supported in part by project 843582 "SenFood", by the femtech project 840000 "PyzoTex", and by the Research Studios Austria project 844724 "SmartColourTextiles" of the Austrian Research Promotion Agency (FFG). This support is gratefully acknowledged.*