# Bioaktive Lyocell-Fasern mit permanenter antimikrobieller und antiviraler Wirksamkeit


Philipp Köhler, 21.06.2024

# TITK Group

**TITK**

**Material, process and technology development**

**OMPG**

**Independent test laboratory for plastics and textiles**

**smart polymer**

**Product management, production and worldwide distribution**

# Thuringian Institute Of Textile And Plastics Research

## Institute for polymer materials research

- Foundation 1991
- About 140 employees in four research departements and administration
- Research partner for companies in the field of materials research
- TITK is specialized in modifying polymers in order to create materials with entirely new, functional properties – polymers of the new generation

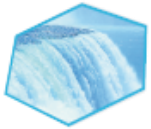

1935 1954 1991

# Commercial available fiber types

Cell Solution™ FILAMENTS

Cell Solution™ CLIMA

Cell Solution™ BIOACTIVE



Smartpolymer Ltd.

smartcel™ sensitive

Cell Solution™ CERAMIC

SeaCell® *active*

smartfiber AG
intelligent world of fibers

Cell Solution™ ENERGY

SeaCell® *pure*

Cell Solution™ HYGENIC

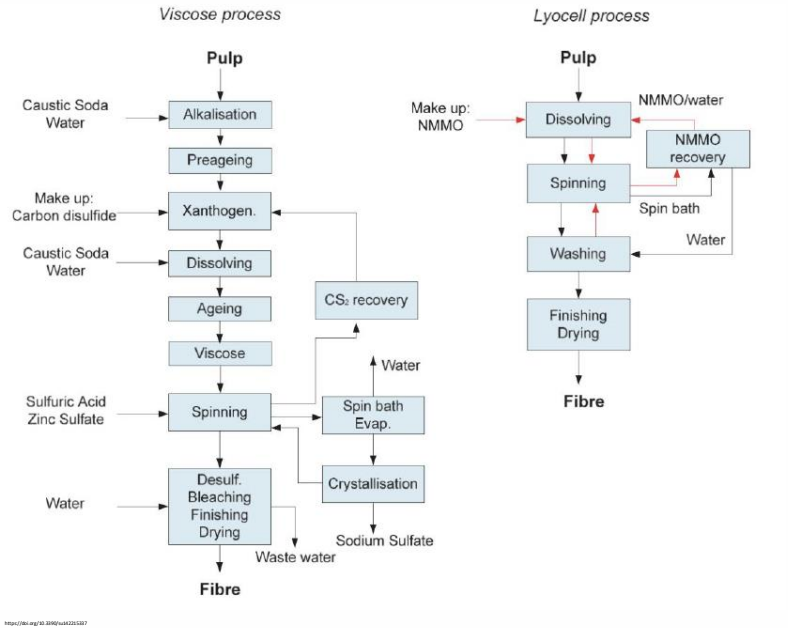
smartcel™ - brand of smartfiber AG

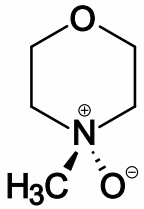
SeaCell® - brand of smartfiber AG

Cell Solution™ - brand of smart polymer Ltd.

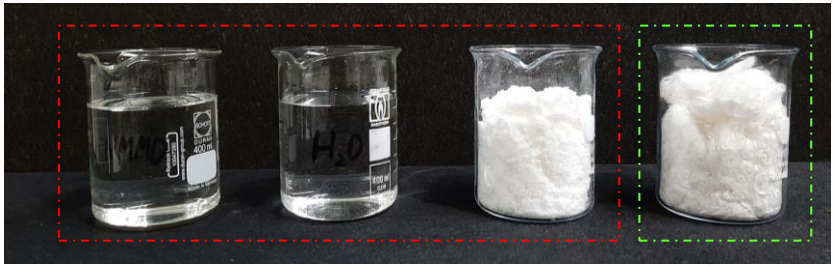
# Celluloseregeneratfasern

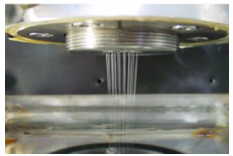
## Zwei industriell relevante Prozesse



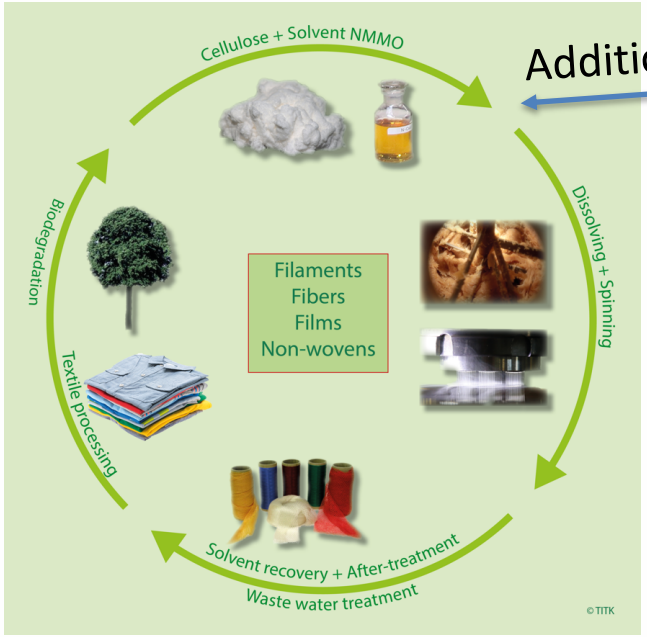




+ $H_2O$ + Zellstoff = CLY

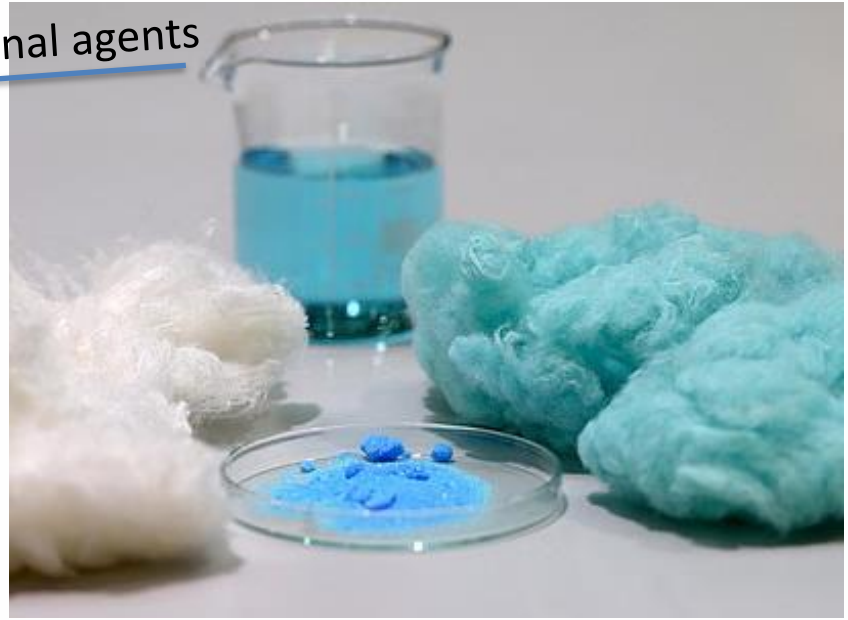




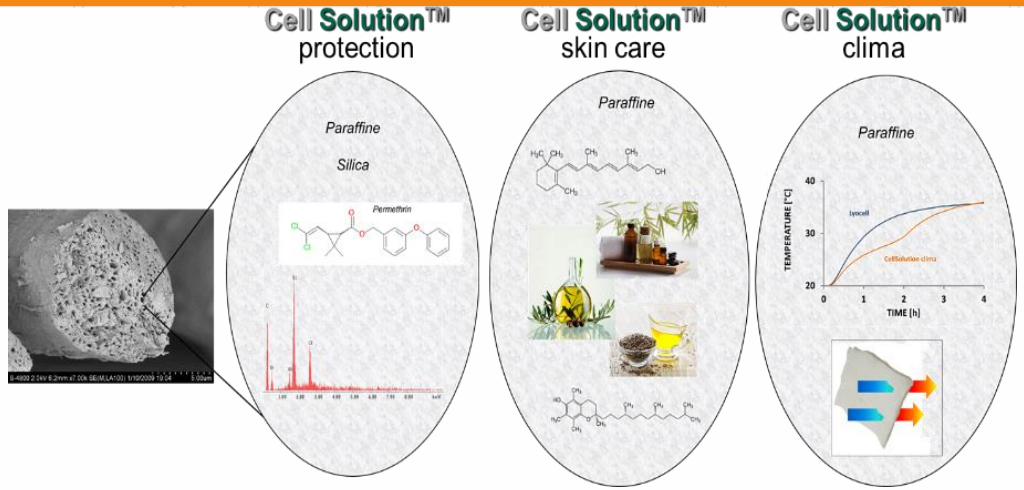
# ALCERU® – modifizerter Lyocellprozess

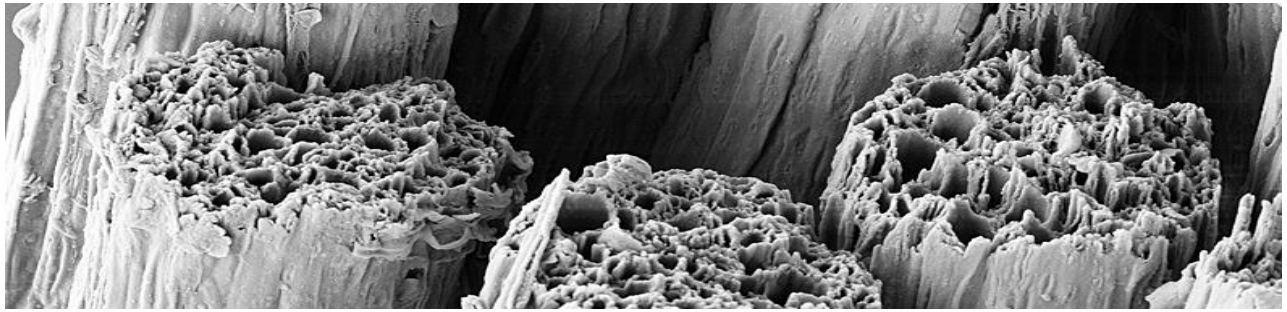



Addition of functional agents



# Alternative types of cellulosics sources – new circular economics

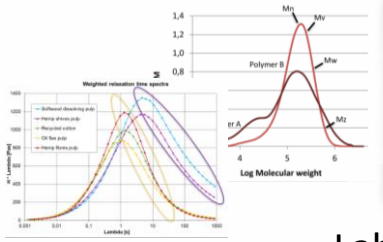


## Lyocell am Standort

### Fasermenge pro Tag

| 30 g | 1 kg | 20 kg | 3600 kg |
|---|---|---|---|




Labor

Technikum

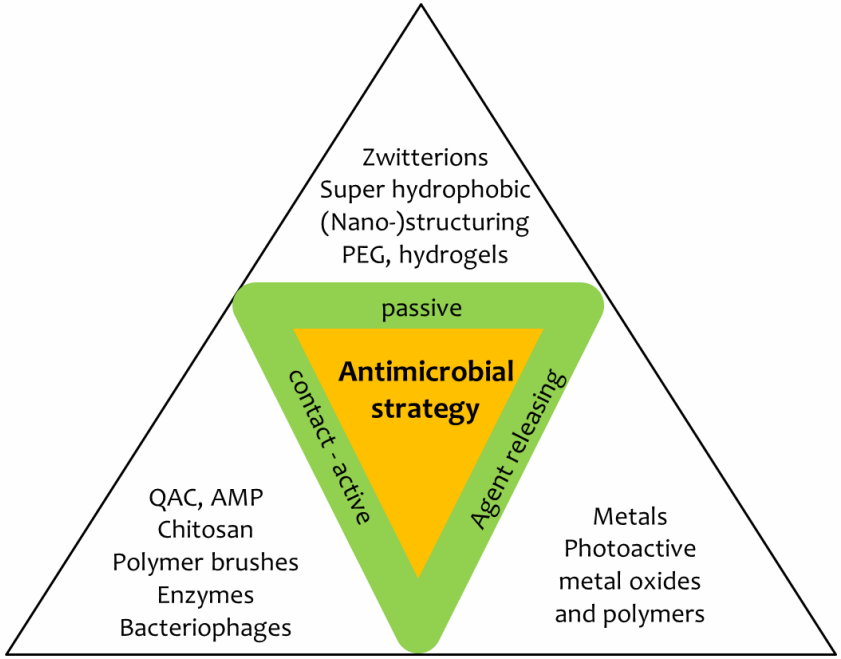
kl. Pilotmaßstab

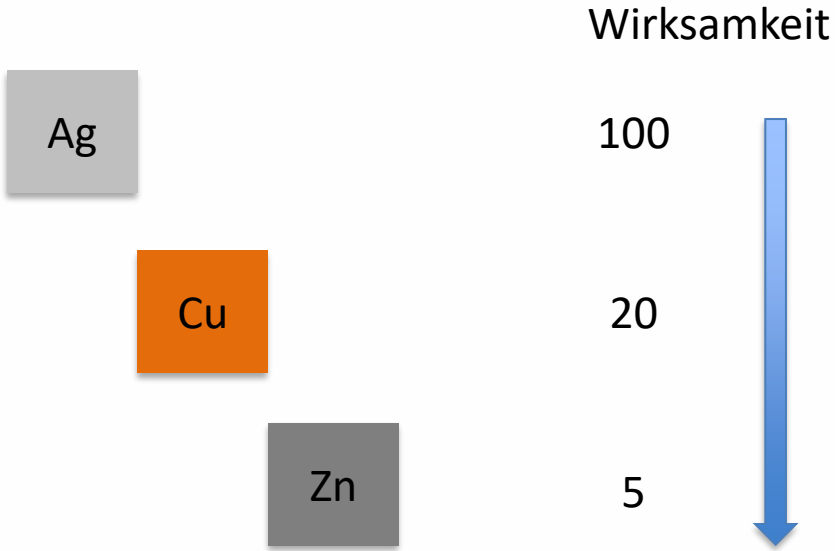
Pilotmaßstab

# Cell Solution® BIOACTIVE

# Cell Solution® BIOACTIVE

## High bioactive efficiency– antibacterial and antiviral



# Cell Solution® BIOACTIVE

- Lyocellfaser
- Ag / Cu
- Hochwirksam gegen Bakterien / Bakterien und Vieren

# Cell Solution® BIOACTIVE

## Ecological high-tech fiber, *three-step* process

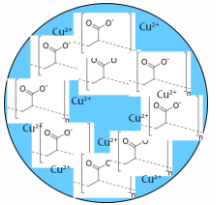
1. ***Incorporation*** of binding polymer into cellulose matrix

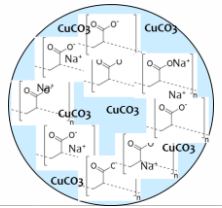
   Acidic and basic ionic exchange resins
   Super absorbing polymers (polyacrylates)
   Polyethylenimines
   Vinyl amine polymers
   Dendritic polymers
   Cellulose derivatives

2. ***Metal salt*** application by immersion bath procedure

   $Ag^{+}$, $Cu^{+/2+}$, $Zn^{2+}$

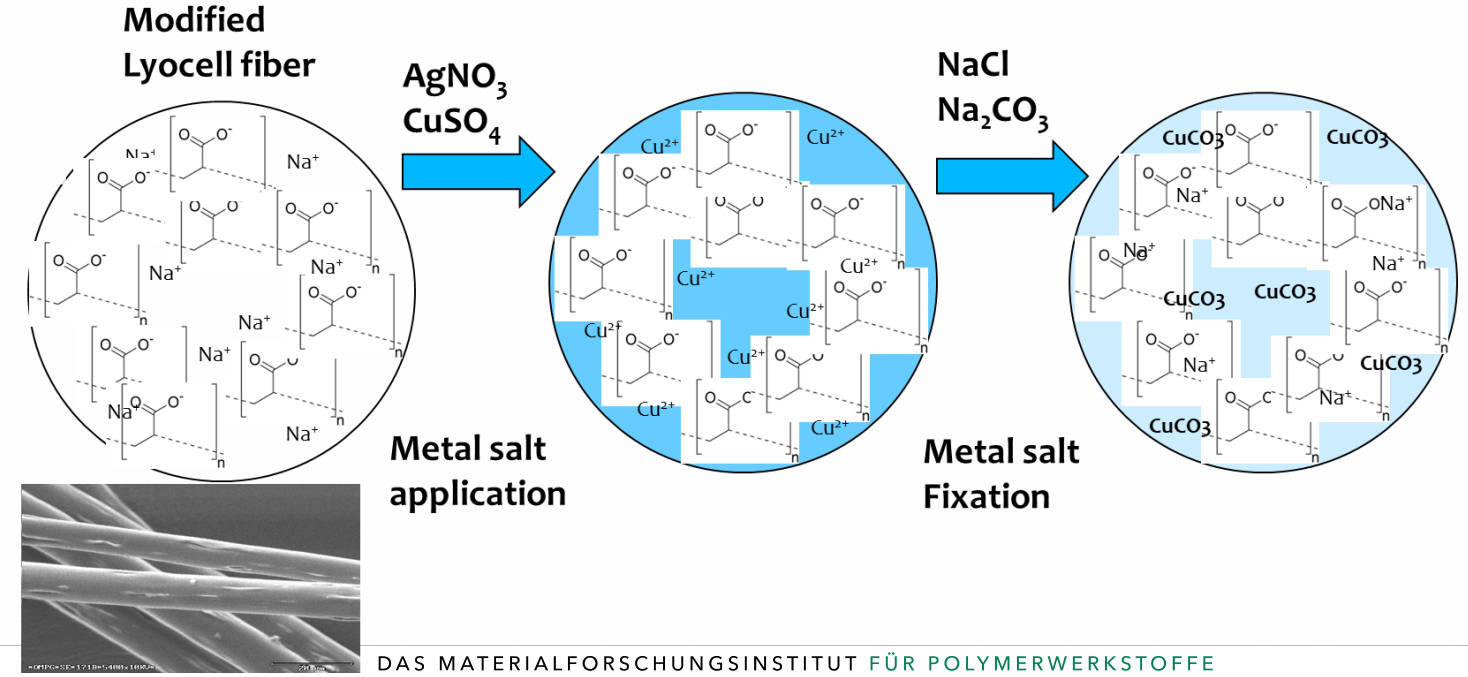
3. ***Fixation*** of metal ion inside fiber (Long lasting effect)

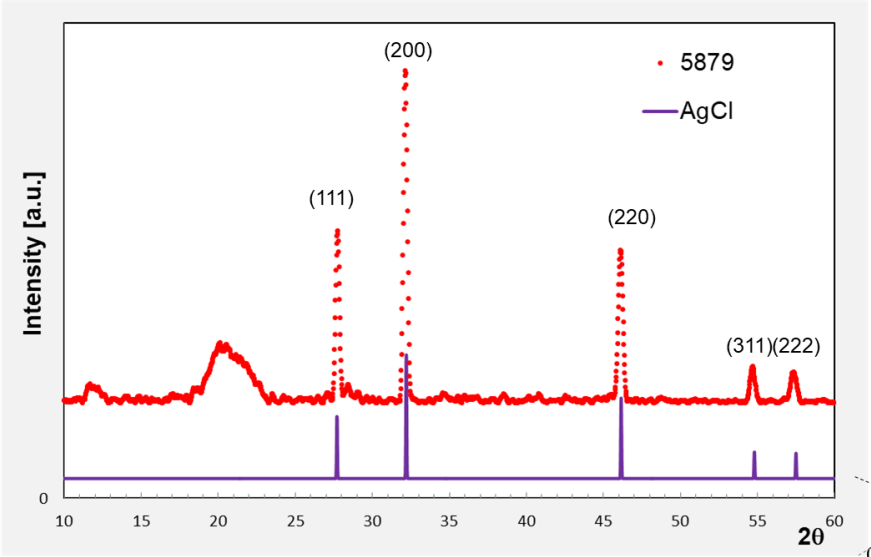

# Cell Solution® BIOACTIVE

## *Three-step* process to impart metal ions for significantly high antimicrobial and antiviral function to the cellulose.

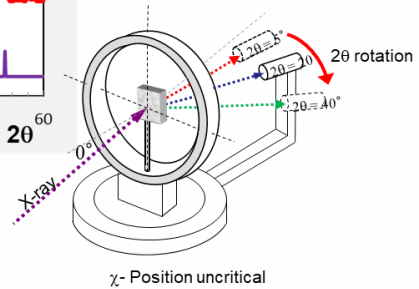


# Cell Solution® BIOACTIVE

## Fixation of silver ions with NaCl




Wide-angle X-ray scattering (WAXS) Bruker AXS GmbH
Dr. Thomas Schulze / TITK




χ- Position uncritical

# Cell Solution® BIOACTIVE

Cell Solution®

Modified Lyocell fiber

Application of CuSO4


Fixation with Na2CO3

**Combination of fixation with valence change**

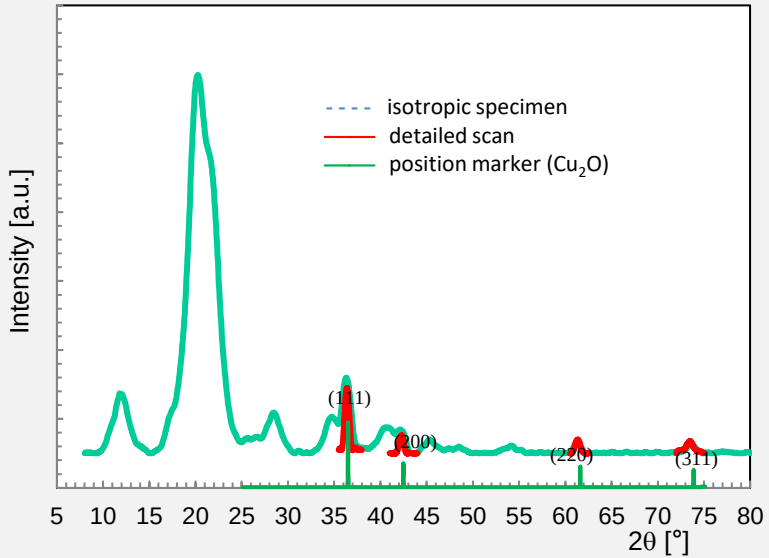

Fixation with Glucose/NaOH

Impregnation of textiles with $Cu_2O$ particles: T. Bechtold: J. Mat. Chem. B, 2015, 3, 5886-5892

# Cell Solution® BIOACTIVE

## Fixation / Reduction of copper(II) with glucose/NaOH

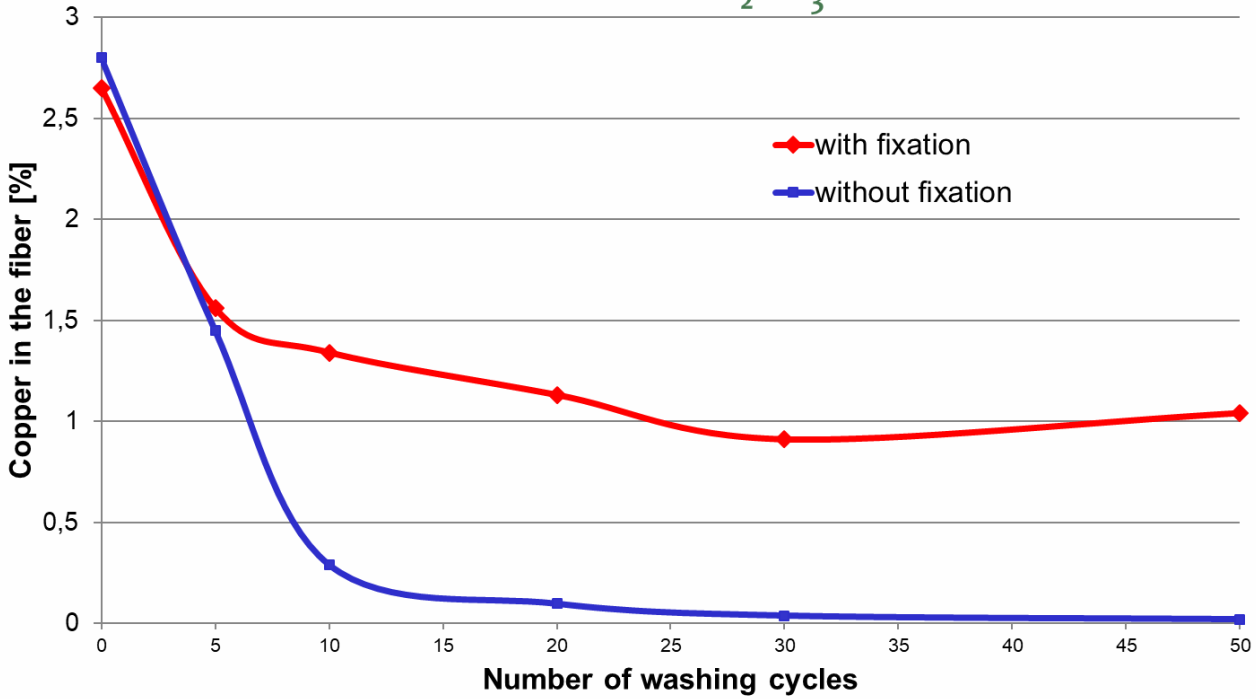
$$2Cu^{2+} + R\text{-}CHO + 4OH^- \Rightarrow Cu_2O + R\text{-}COOH + 2H_2O$$




Wide-angle X-ray scattering (WAXS) Bruker AXS GmbH

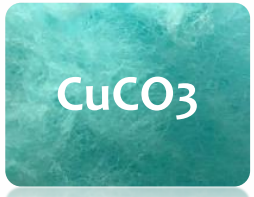
# Cell Solution® BIOACTIVE

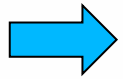
## $CuSO_4$ application on/in to the fiber - fixation with $Na_2CO_3$



# Cell Solution® BIOACTIVE

$$2Cu^{2+} + R\text{-}CHO + 4OH^- \Rightarrow \mathbf{Cu_2O} + R\text{-}COOH + 2H_2O$$



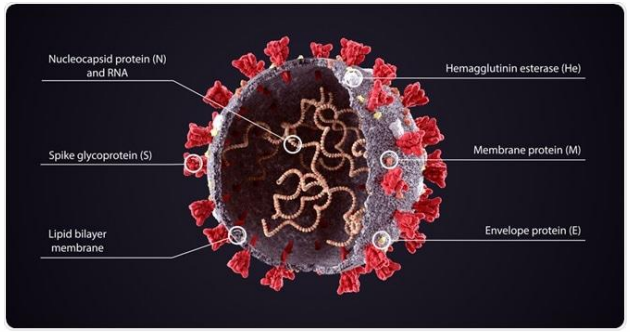

$$2Cu^{+} + 2O_2\ (aq) \Rightarrow 2Cu^{2+} + 2O_2^-$$

$$2O_2^- + 2H^+ \Rightarrow H_2O_2 + O_2$$

$$Cu^{+} + H_2O_2 \Rightarrow Cu^{2+} + OH^- + OH^{\bullet} \quad \text{(Fenton reaction)}$$

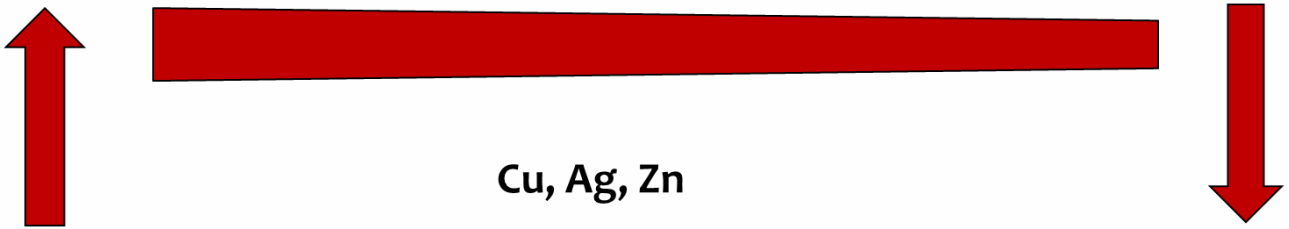
## $OH^{\bullet}$ radicals degrade viral proteins

S.L. Warnes, Z.R. Little u. C.W. Keevil: Human Coronavirus 229E Remains Infectious on Common Touch Surface Materials. mBIO 6(6):e01697-15 (2015).
ttps://www.news-medical.net/health/What-are-Spike-Proteins.aspx



# Cell Solution® BIOACTIVE

## Functionalities throughout the complete textile chain

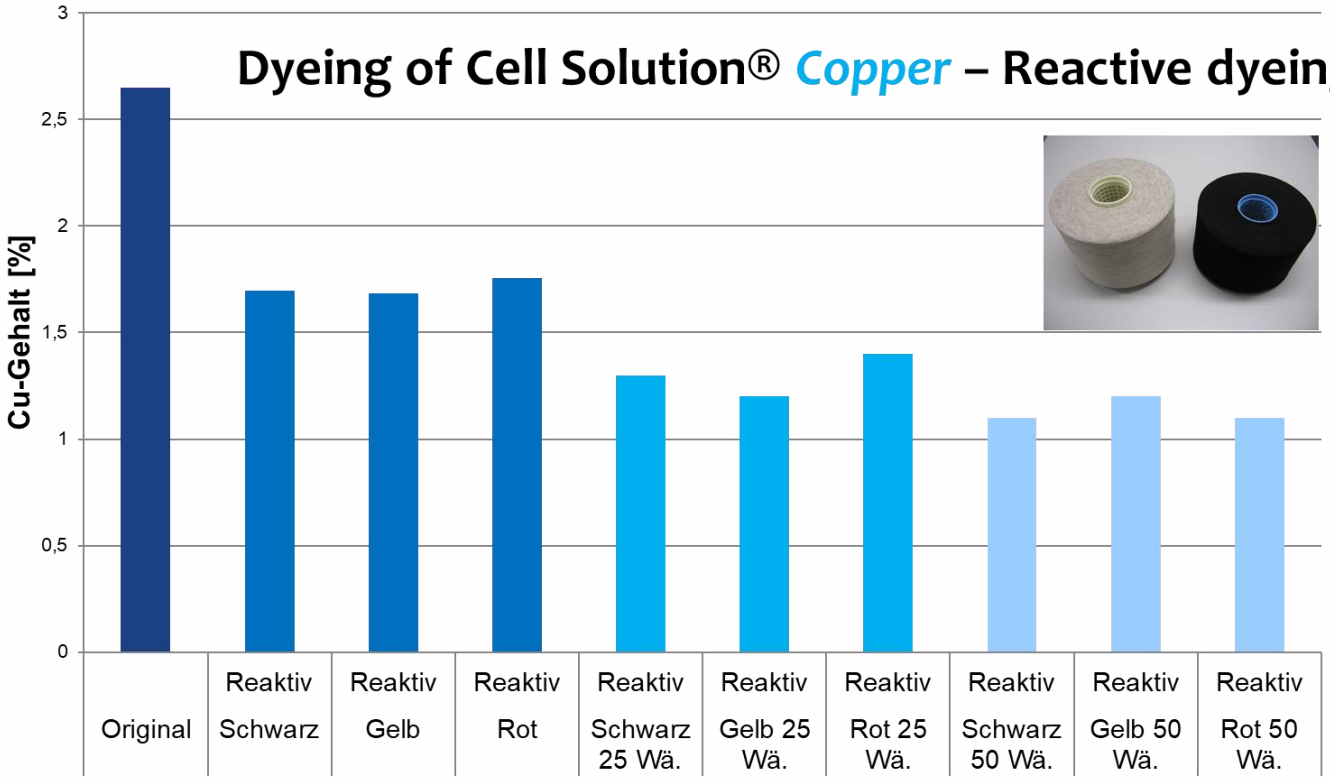
**Cu, Ag, Zn**

AAS, ICP-OES

**Identification of the required additive concentration**

**Verification of the required additive concentration**

# Cell Solution® BIOACTIVE



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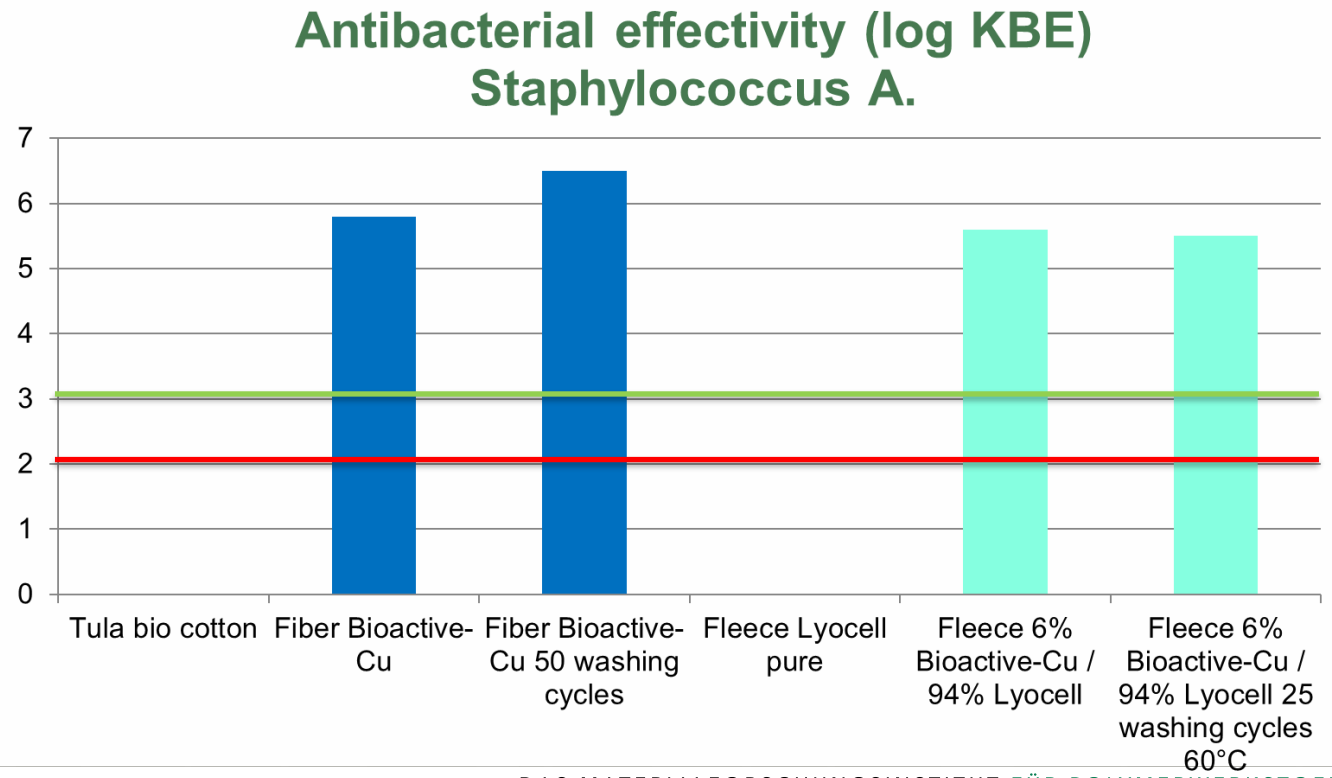


**Antibacterial test acc. ISO 20743**

Significant antibacterial effectiveness

Strong antibacterial effectiveness

# Cell Solution® BIOACTIVE

TITK

## Antiviral effect proved

## acc. International Standard ISO 18184:2019

1. Micromun Institute GmbH, test report 17 Dec. 2020
2. Hohenstein 20.8.3.0199/1
3. OMPG F088.11_45Bio

**Non-enveloped viruses:**
- **Norovirus**

**Enveloped viruses:**
- **Influenza**
- **COVID-19**

HOHENSTEIN

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Zuständig für Rückfragen / *Contact person*: Jutta Secker
Unser Zeichen / *Our ref.*: jkr
Datum / *Date*: 30. Juli 2020

**Bericht Nr. / *Report No.* 20.8.3.0199/1**

| | |
|---|---|
| **Auftraggeber:** *Client:* | siehe Anschrift *see address* |
| **Prüfgegenstand:** *Test sample:* | siehe Seite 2 *see page 2* |
| **Auftragsdatum:** *Date of order:* | 13.07.2020 |
| **Eingang Prüfgegenstand:** *Receipt of test samples:* | 13.07.2020 |
| **Prüfzeitraum:** *Period of testing:* | 28.07.2020 bis / to 30.07.2020 |
| **Probenahme:** *Sampling:* | Der Prüfgegenstand wurde uns vom Auftraggeber übersandt. *The test sample has been delivered to us by the client.* |

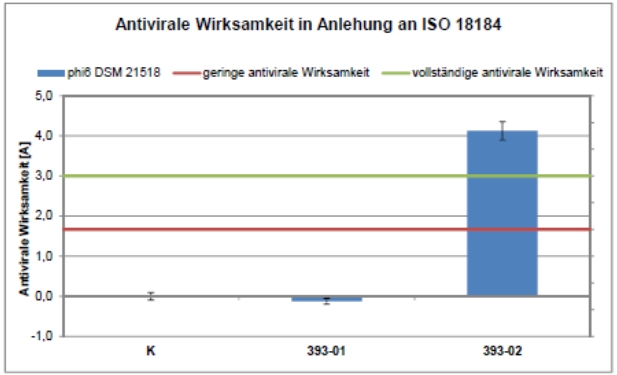
# Cell Solution® BIOACTIVE

Management-Formblatt zu SAA_4.5_524Bio
Antivirale Wirksamkeitsprüfung von Textilien
ISO 18184:2014

Code: F088.11_45Bio
Revision: 01
gültig ab: xx.xx.2021


**Zusammenfassung der Ergebnisse:**

| Probenbezeichnung | | M | | lg M | | log- | | F | G | A | Effektivität der antiviralen Wirksamkeit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0h | 24h | 0h | 24h | 0 h | 24 h | | | (F-G) | |
| K | Referenzprobe Polyestervlies F5 (2145B-0029-00) | 7,00E+07 | 2,40E+07 | 7,84 | 7,38 | 0,08 | 0,19 | -0,46 | -0,46 | 0,0 | nicht wirksam |
| 393-01 | V 3736 SAP 15.5.20 | - | 3,17E+07 | - | 7,50 | - | 0,44 | - | -0,34 | -0,1 | nicht wirksam |
| 393-02 | V3637 SAP (Cu2O) nach 50 Wäschen (3x o. WM) (vorm. 383, 384) | - | 1,80E+03 | - | 3,26 | - | 1,44 | - | -4,59 | 4,1 | stark |




**Beurteilungskriterien**

| Antivirale WirkungR | Effektivität der antiviralen Wirksamkeit |
|---|---|
| 2,0 > R | keine antivirale Wirksamkeit |
| 3,0 > R > 2,0 | geringe antivirale Wirksamkeit |
| R ≥ 3,0 | vollständige antivirale Wirksamkeit |

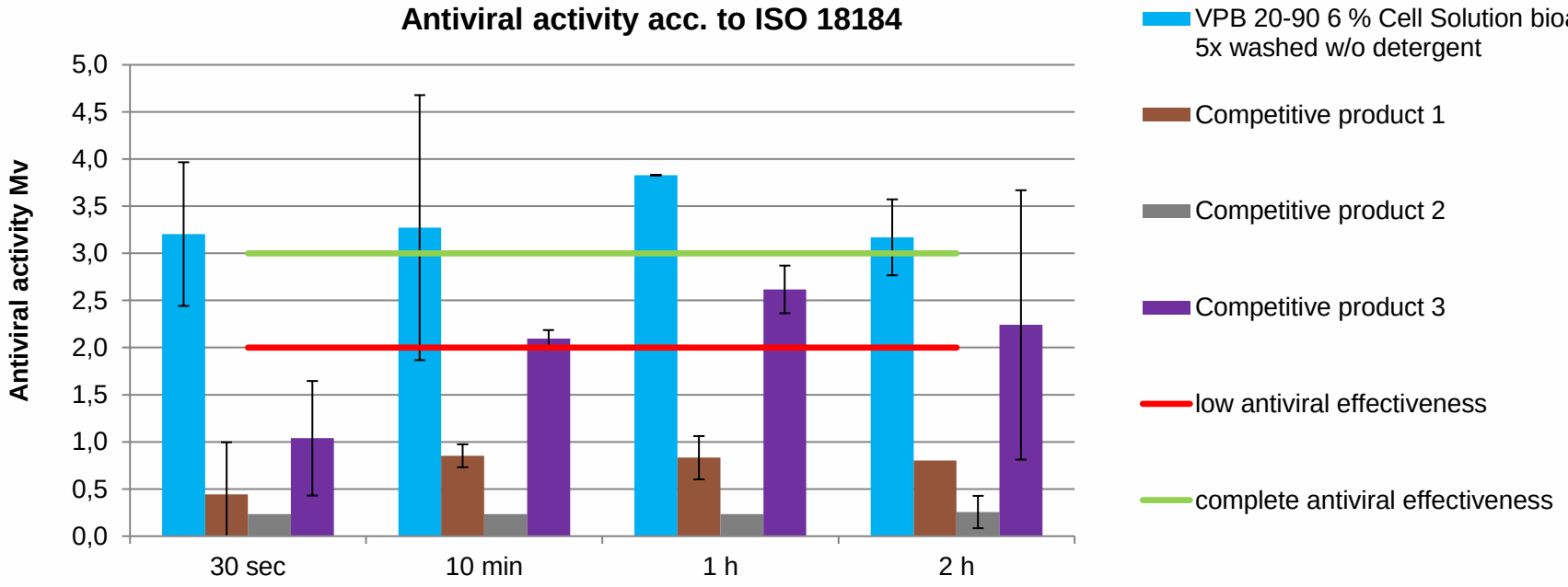
**After 50 washing cycles:**

**Ca. 100 ppm Copper in the fiber**

Durchgeführt und Daten geprüft von:
Berechnung und Auswertung geprüft von:

T:\DigitalesLaborbuch\Prüfprotokolle_2021\Antivirale_Testungen\TITK\
393_18184_Dr. Wendler.xlsx

# Cell Solution® BIOACTIVE




## Fields of application

- OP clothes, ***hospital linen***
- Nonwovens for ***face masks***
- Home textiles such as bedding, bedlinen, mattresses
- **Technical applications** as filtration, e. g. for ***air condition.***

# Vielen Dank!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epnoe

ZUSE-GEMEINSCHAFT
FORSCHUNG, DIE ANKOMMT.