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IMMOBILISATION OF ANTIBIOTIC TETRACYCLINE ON SILICA NANOFIBRES

I. Šlamborová[1], V. Zajícová[1], J. Karpíšková[2] and P. Exnar[1]

[1]Department of Chemistry, Faculty of Science, Humanities and Education, Technical University of Liberec, Studentska 2, 461 17 Liberec, Czech Republic
[2]Institute of Novel Technologies and Applied Informatics, Faculty of Mechatronics, Informatics and Interdisciplinary Studies, Technical University of Liberec Studentská 2, 461 17 Liberec, Czech Republic
irena.slamborova@tul.cz

Abstract: *Silanization of substrates with Si-OH groups on the surface is one of the methods currently used in engineering of special materials. Such modification allows e.g. immobilisation of drugs on different surfaces. In this study, tetracycline was successfully immobilised through silanization reactions on silica nanofibres with Si-OH groups. The immobilisation of tetracycline was confirmed by fluorescent microscopy (Olympus BX51, camera DP 72) and it was also proved by their antibacterial effect on selected bacterial strains. The silanization reactions were performed in different solvents. The best results were obtained when the silanization proceeded in water with a rinse in acetic acid.*
Key words: *nanofibre, silanization, organosilane, immobilisation, tetracycline, antibacterial effect.*

1 INTRODUCTION

Silanization reactions are known as an important part of material sciences, especially special modifications of surfaces. The first step of silanization is physisorption of alkylalkoxysilanes onto a surface, followed by a rapid hydrolysis of alkoxy groups (methoxy or ethoxy groups), yielding the formation of hydroxyl groups that can covalently interact with silanol on the surface [1]. Active groups Si-OH or Al-OH are needed for a proper silanization process. Non-reactive organic groups (methyl, phenyl, hexadecyl etc.) on the surface of substrates cause only surface changes and alter wetting properties (hydrophobic and hydrophilic surface). When amino groups are connected to silanes, drugs or biological agents can react with these groups. This is also one of the possible applications of silanization reactions. There are a numbers of organosilane coupling reagents commercially available that can be utilized for immobilisation of, for example, DNA, other biological molecules, or drugs.
For instance,
(3-aminopropyl)triethoxysilane (APTES), (3-aminopropyl)trimethoxysilane (APTMS), (3-glycidyloxypropyl)trimethoxysilane (GPS) and inhibitionacetamidosilanes have been used extensively for this purpose [2].
Antibiotics are used in the pharmaceutical and chemical industry because of their high degree of specificity; antibiotics immobilisation is an effective way to increase their degree of specificity to some extent. The results of immobilisation, including performance of immobilised drugs, strongly depend on properties of supports, which are usually referred to as various material types, compositions and structures. Nanofibres have a great potential and may be promising supports for antibiotics immobilisation. The drug-immobilised nanofibres can be used in public health [3, 4].

2 METHOD

Experiments proceeded with one type of nanofibres prepared by the electrospinning method at TUL. Silica nanofibres were prepared from tetraethylorthosilicate (TEOS, Merck, 98%) as a precursor for the sol-gel method. For immobilisation the antibiotic tetracycline (Sigma-Aldrich >88%) was used.

2.1 Process of silanization

For the silanization experiments, 2 wt% solutions of 3-aminopropyl trimethoxysilane - APTMS (Sigma-Aldrich, 97%) in various solvents were used (1 hour reaction time at ambient laboratory temperature). The reaction is schematically described in Figure 1. The tested solvents included water, isopropanol and cyclohexane. The effect of increased temperature was investigated during the experiments with cyclohexane (81°C, with reflux condenser). After the silanization process, the nanofibre samples were repeatedly rinsed with pure solvents. In the experiment using water as the solvent, the sample was also subsequently rinsed with diluted acetic acid (AcOH, 0.1 wt%) in order to remove the surplus reactants.

2.2 Process of immobilisation

The antibiotics were immobilised on nanofibre substrates by the following method. Tetracycline reacted with the APTMS silanized nanofibres in dry ethanol with constant stirring. The mixture was filtered and washed and the immobilised nanofibres obtained were heated at 75°C in a vacuum for 20 hours [6]. The immobilisation of the antibiotic on the nanofibre substrate is depicted in Figure 1 [5].

2.3 Antibacterial tests

The bacterial inoculum at a concentration about 10^5 CFU (Colony Forming Unit) per ml was inoculated on the blood agar. Nanofibres about the size of 3x3 cm containing immobilised antibiotics were placed in the middle of a Petri dish inoculated with bacterial inoculum. The samples were incubated for 24 hours at 37°C in the thermostat. The size of inhibition zones (i.e. pure area around the nanofibre substrates) was evaluated as a function of the incubation time (Figure 3).

For the antibacterial tests, bacterial strains that are the reference cultures of microorganisms (according to ALE-G18, CSNI) were used. The bacterial strains were purchased from the Czech Collection of Microorganisms, Masaryk University in Brno, the Czech Republic. Gram-negative (G-) rod-shaped bacterium *Escherichia coli* (CCM 2024), Gram-positive (G+) cocci bacterium *Staphylococcus aureus* (CCM 299), Gram-positive (G+) cocci bacterium *Methicillin-resistant Staphylococcus aureus - MRSA* (CCM 4223), Gram-negative (G-) rod-shaped bacterium *Acinetobacter baumanii* (CCM 2265), Gram-negative (G-) rod-shaped bacterium *Proteus mirabilis* (CCM 1944). For the cultivation of bacteria, blood agar (Columbia agar) from Bio-Rad, Prague was used. For the immobilisation the antibiotic tetracycline from Sigma-Aldrich was purchased.

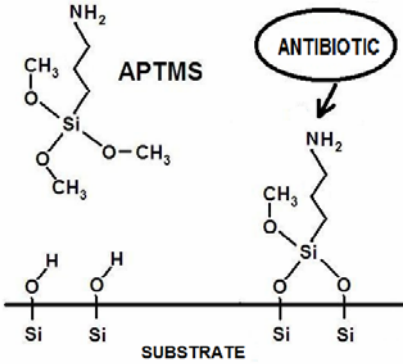


Figure 1 The scheme of immobilisation reactions of antibiotics (APTMS - 3-aminopropyl trimethoxysilane)

3 RESULTS AND DISCUSSION

The immobilisation of tetracycline was confirmed on all samples. Unambiguously, of all the samples tested, SiO_2 nanofibres achieved the best results of antibiotic immobilisation. The size of inhibition zones clearly proved antibacterial effect of the immobilised tetracycline. The inhibition zones of samples treated with *E. coli* contain little bacterial colonies. The inhibition zones of samples treated with the other bacterial strains used (including *S. aureus*) are absolutely pure, without any bacterial colonies. The results obtained correspond with the well-known effect of individual antibiotics on the tested bacteria. In all cases, no differences were found among the samples of nanofibres rinsed and not rinsed

with the acetic acid. The analytical validation of the immobilisation of the antibiotic tetracycline on the nanofibres is now a subject of subsequent research. Figures 2a, 2b and 2c were scanned by means of fluorescent microscopy. In Figure 2a, a nanofibre substrate without tetracycline is depicted. Figure 2b depicts crystals of tetracycline. Figure 2c clearly shows white places, which confirms the immobilisation of tetracycline on the SiO_2 nanofibres.

The possibility of immobilisation of tetracycline on SiO_2 nanofibres was tested and compared. Figure 2c represents the confirmation of the immobilisation of tetracycline on the surface of the prepared samples. All series of the samples (Figure 3) represent a method in which the antibiotic was applied on nanofibre substrates from its solution. The results of inhibition against all bacterial strains tested were very similar. The series of testing samples containing tetracycline were extended by testing on additional bacterial strains that cause serious problems, especially in dermatology. The results obtained are summarized in Table 1.

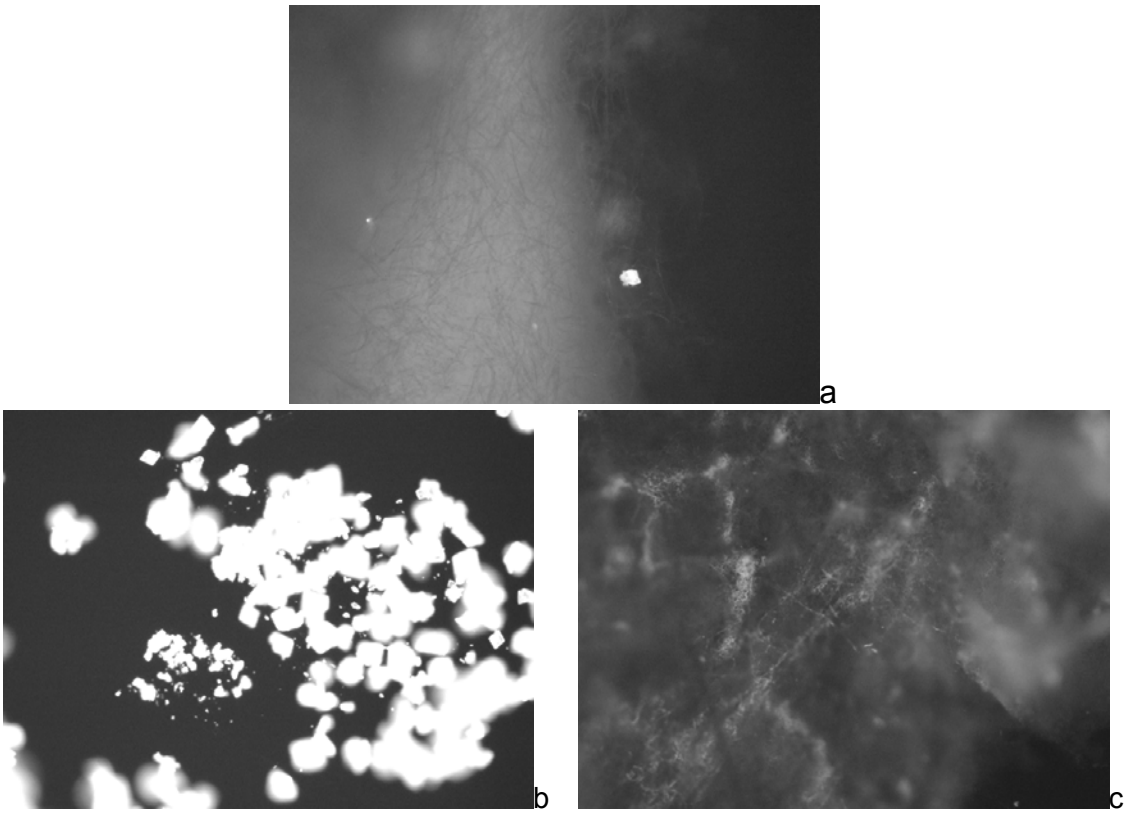
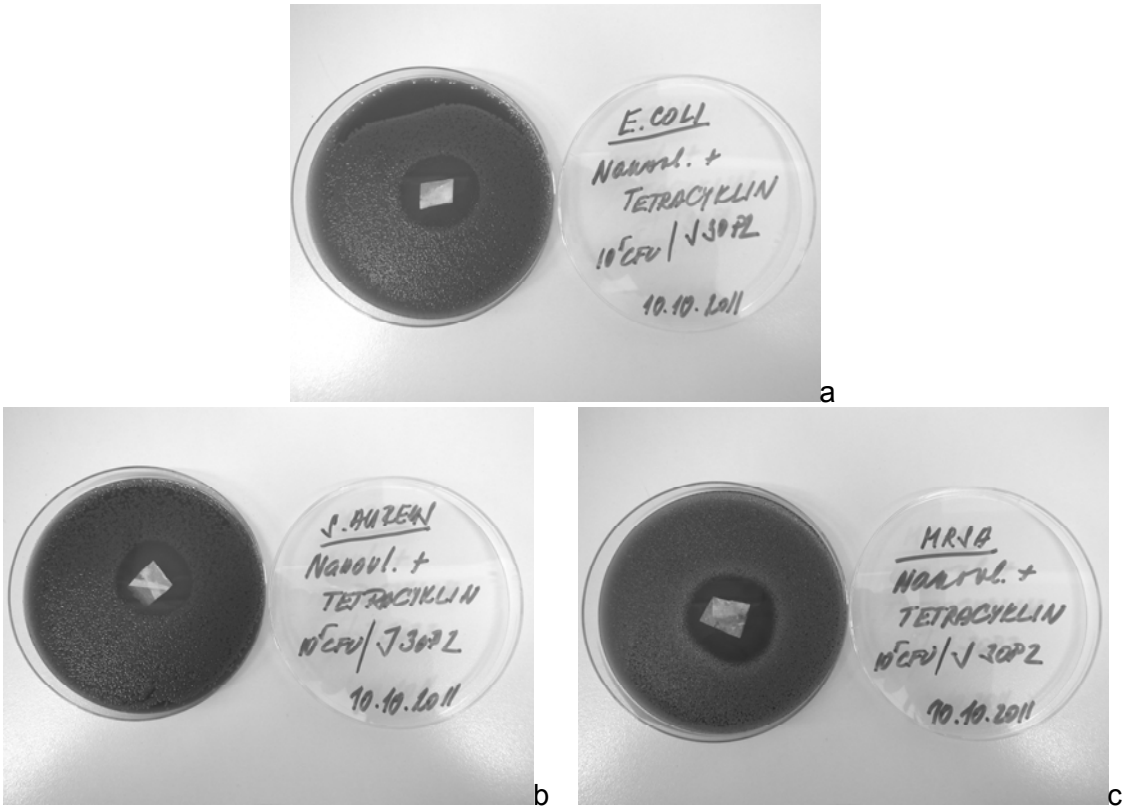


Figure 2a A nanofibre substrate without immobilised tetracycline.
Figure 2b, c Crystals of tetracycline (b), yellow places - tetracycline immobilised on the nanofibres (c). The image was obtained from the fluorescent microscope Olympus BX51, camera DP72, aggrandisement 200x (Department of Textile Evaluation, Faculty of Textile Engineering, TUL)



a b c

Figure 3 Antibacterial effect of tetracycline immobilised on SiO_2 nanofibres. A large, clear inhibition zone can be observed - the effect of inhibition against *E. coli* (a), *S. aureus* (b) and *MRSA* (c) is excellent

Table 1 The results of inhibition testing on bacterial strains

Tested bacterial strain	Inhibition zone	Results of inhibition
***E. coli* (G-)**	5 cm large, clear (without bacterial growth)	excellent
***S. aureus* (G+)**	4.5 cm large, clear (without bacterial growth)	excellent
***MRSA* (G+)**	5 cm large, clear (without bacterial growth)	excellent
***A. baumanii* (G-)**	5 cm large, clear (without bacterial growth)	excellent
***P. mirabilis* (G-)**	very small – 4 mm	minimum

4 CONCLUSION

The surfaces of SiO2 nanofibres were successfully silanized using a number of different processes. The best results were obtained after silanization from water with the rinse in acetic acid. Tetracycline is a bacteriostatic antibiotic which inhibits multiplication of bacteria. It can penetrate into bacterial cells and inhibit protein biosynthesis. It is an antibiotic with a broad spectrum of action against (G+) and (G-) bacteria.

The results of testing showed that the best effect of inhibition was observed on these bacterial strains: E. coli, S. aureus, MRSA and A. baumanii. Slight inhibition was

observed against P. mirabilis. These results clearly present the possibility of using antibiotics-immobilised nanofibres as bandage materials for patients with difficult-to-heal wounds. This mechanism of immobilisation can be also used as a means of immobilising other types of antibiotics.

Acknowledgements: *This work was supported by the Project advanced processes and redevelopment technologies (number 1M0554, Czech Republic) and by the project SGS (number 5843, MSMT Czech Republic).*

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IMOBILIZACE ANTIBIOTIKA TETRACYKLINU NA KŘEMIČITÁ NANOVLÁKNA

Translation of the article
Immobilisation of antibiotic tetracycline on silica nanofibres

Abstrakt: Silanizace substrátů obsahujících na svém povrchu Si-OH skupiny je jednou z metod používaných v současné době v inženýrství speciálních materiálů. Uvedená metoda umožňuje např. imobilizaci léčiv na různé povrchy. V této studii byl úspěšně imobilizován tetracyklin na silanizovaná křemičitá nanovlákna s Si-OH skupinami. Imobilizace tetracyklinu byla potvrzena fluorescenční mikroskopií (Olympus BX51 , kamera DP 72). Na vybraných bakteriálních kmenech byl také prokázán výrazný baktericidní účinek připravených nanovlákenných substrátů. Silanizační reakce byly prováděny v různých rozpouštědlech. Nejlepších výsledků bylo dosaženo silanizací nanovlákenných substrátů ve vodě s oplachem kyselinou octovou.

THE EVALUATION OF THE SURFACE ACTIVITY AND SEQUESTRATION CAPACITY OF PREPARED SAMPLES OF BIODEGRADABLE SELF-SEQUESTERING SURFACTANTS

L. Krištofíková, P. Bayerová and L. Burgert

University of Pardubice, Institute of Chemistry and Technology of Macromolekular Materials
Studentská 573, 532 10 Pardubice, Czech Republic
LuckaKristof@seznam.cz

Abstract: *At present we put mind to tensides (surfactants) with sequestration effects. The sequestration capacity and surface activity of prepared samples are discussed in this study.*
In this case it goes about self-sequestrate agents, where ester linkage makes a bond between polar and non-polar part of molecule. These samples are prepared by reaction of maleic anhydride with products based on fatty alcohols. The surface activity was evaluated at prepared agents and it was compared with commercial tenside. Surface tension was measured of stalagmometric method. The sequestration capacity was evaluated to Ca^{2+} ions by precipitating opacity titration - so called Hampshire test, at 20°C and 98°C at a range of pH-values 9 to 12.
Key words: *self-sequestering surfactants, sequestration capacity, surface tension, surface activity of tensides*

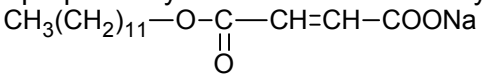
1 INTRODUCTION

Tenside is a surface-active substance. These substances change conditions of reaction on the interface even at low concentrations, which has primarily a reduction in surface tension as consequence. Surfactants have a bipolar chemical structure - each containing one hydrophilic and one hydrophobic part. And it is further divided in terms of ionic character of the hydrophilic (= polar) group to the ionogenic and nonionic. Surfactants accelerate the technological processes, reduce friction, stabilize disperse systems and affect the physical - mechanical properties. Since surfactants reduce the surface tension of solvents, facilitate the dissolution and removal of impurities. Therefore they are often used in cleaning and laundry detergents [1].
Sequestering agents are generally compounds that form chelates with the definite cation, which are specific types of complex compounds surrounding the cation. This will prevent the adverse effect of the cations – e.g. formation of hard soluble compounds of calcium or ferric. An important area of application of these compounds is the preparation of detergents, use in textile finishing baths, for the water softening or dyeing of cellulose materials. Then the self - sequestering surfactants should combine the properties of surfactants and sequestering agents. And considering to the environment they should also have biodegradability.
There are various ways of preparation of self-sequestering surfactants, when the starting materials are fumaric acid reacting with polyoxyethylated stearyl ether [2], or the synthesis of itaconic acid, phthalic anhydride, citric acid and oxypropylated diols [3] or phthalic anhydride, citric acid and polyethylene glycol [4]. Another option is to prepare a mixture of amides of polyaminopolycarboxylic acids and their salts, alternatively mixtures of detergents containing self-sequestering molecules of tenside [5].

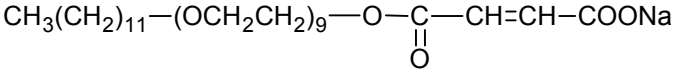
2 EXPERIMENTS

2.1 The prepared samples

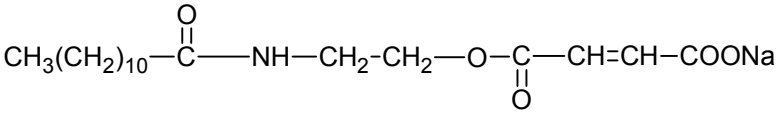
Sample no.1 - prepared by reaction of maleic anhydride with lauryl alcohol [molar ratio 1:1]



Sample no.2 - prepared by reaction of maleic anhydride with Lutensol A2N (oxethylated fatty alcohols) [molar ratio 1:1]



Sample no.3 - prepared by reaction of maleic anhydride with Comperlan 100 (monoethanolamide of fatty acids) [molar ratio 1:1]



2.2 Evaluation of sequestration capacity

The sequestration capacity of prepared agents was evaluated to Ca^{2+} ions by precipitating opacity titration - so called Hampshire test, at 20°C and 98°C at a range of pH-values 9 to 12. Measuring at 98°C → a solution of sequestering agent was tempered on 98°C and then titrated.

A solution of $CaCl_2.6H_2O$ was selected as a volumetric solution. The equivalence point was determined by measuring of absorbance of created opacity at waving length 650 nm, in cell 1 cm - (Spectrophotometer Spekol 11 - Carl Zeiss) and consequent evaluation of measured dependences.

2.3 Evaluation of surface tension

For the measurement there was used a stalagmometric method. It is a relative method, in which are compared the numbers of drops of the known liquid n_1 of known surface tension y_1 with the number of drops of the measured liquid n_x, in which we find the surface tension. Between the measured and reference liquid (in this case distilled water) the following relation holds:

$$\mathbf{n_x.\gamma_x = n_1.\gamma_1 \rightarrow \gamma_x = n_1.\gamma_1/n_x}$$

$\gamma_1 = 72.75 \cdot 10^{-3}$ N.m^{-1} (at 20°C)

The surface activity was evaluated at prepared agents and it was compared with commercial tenside.

3 RESULT AND DISCUSSION

Surface activity was measured of stalagmometric method. The presence of sufficiently high alkyl is a precondition for an ability of the product be behave itself as a surface-active substance. Measured surface tension is comparable with commercial product of sodium dodecylsulfate – Table 1, Figure 1.

Table 1 Values of surface tension measured in depending on concentration of prepared samples and sodium dodecylsulfate

Concentration [g/l]	Surface tension [mN/m]			
	SAMPLE no. 1	SAMPLE no. 2	SAMPLE no. 3	Sodium dodecylsulfate
0.1	57.06	48.10	37.31	71.31
0.25	52.91	42.79	33.07	62.11
0.5	46.93	38.04	30.63	56.36
0.75	41.57	36.38	28.53	51.39
1	40.42	32.15	27.71	47.22
1.5	39.32	30.47	27.45	40.40
2	37.31	29.69	25.09	36.21

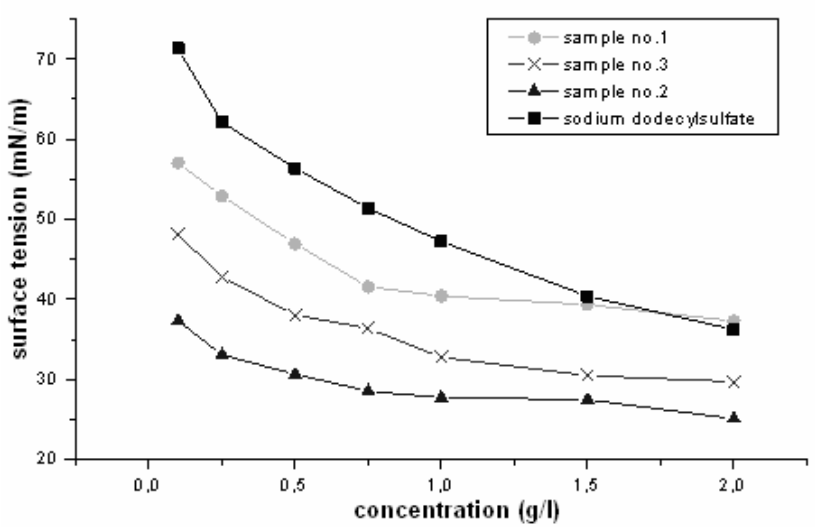


Figure 1 Dependence of surface tension on concentration by prepared samples and by commercial tenside

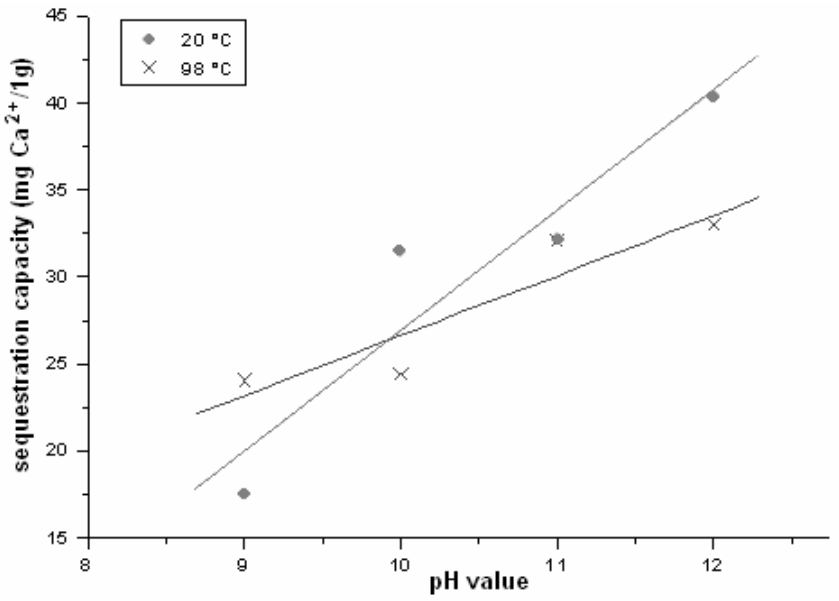


Figure 2 Dependence of sequestration capacity Ca^{2+} on pH value at 20°C and 98°C for sample no.1

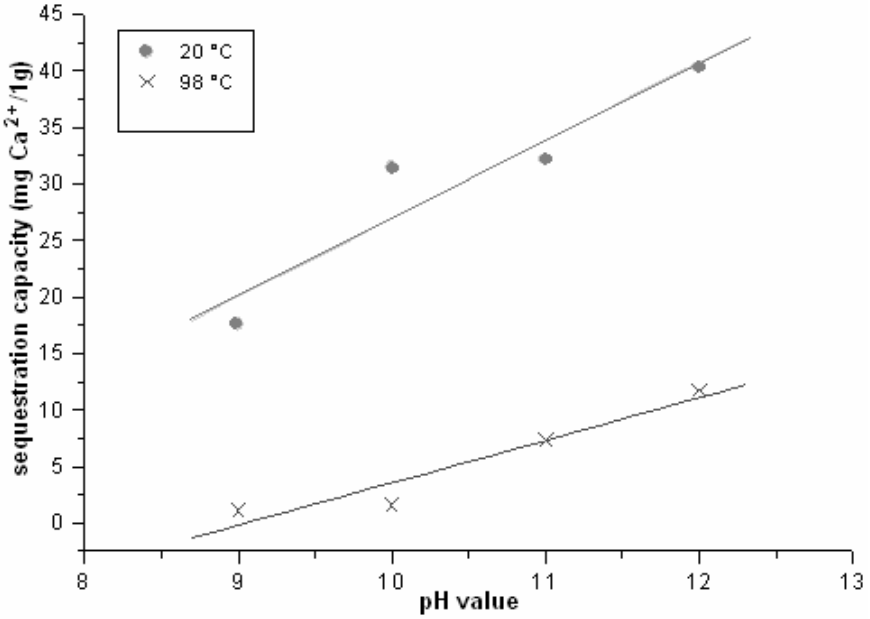


Figure 3 Dependence of sequestration capacity Ca^{2+} on pH value at 20°C and 98°C for sample no.2

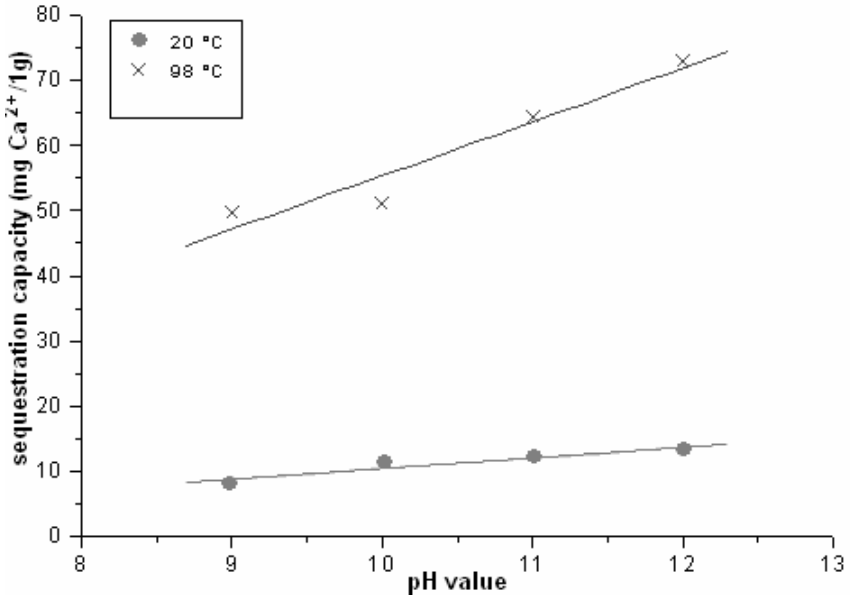


Figure 4 Dependence of sequestration capacity Ca^{2+} on pH value at 20°C and 98°C for sample no.3

The sequestration capacity was evaluated at prepared three agents. If the sequestration capacity is evaluated in relation to pH value, the sequestration linearly goes up with increasing pH-value. The above-mentioned behaviour of sequestration effect was confirmed at all prepared samples – Figures 2, 3, 4.

The sequestration efficiency depended on increasing temperature. Samples no.1 and no. 3 show an increase of the sequestration capacity at hot determination. This fact is useful for washing textiles at high temperature or for boiling.

The biodegradability of prepared samples was measured under standards effective in EU. Measured values exceed 70% (Table 2). These results meet limits stipulated by international agreements of EU. This limit is 60%.

Table 2 Values of biodegradability

	Sample no. 1	Sample no. 2	Sample no. 3
Biodegradability	72.1%	73.8%	72.1%

4 CONCLUSION

In this work basic properties of three prepared samples of self-sequestering tensides were evaluated. These samples are prepared by reaction of maleic anhydride with products based on fatty alcohols, where ester linkage makes a bond between polar and non-polar part of molecule. These samples have a good surface activity. Measured surface tension is comparable with commercial product of sodium dodecylsulfate. The sequestering ability is relatively low. However lower values were expected by chemical structure of the samples, when number of functional group necessary to sequestration is low. Great benefit of prepared samples is their good biodegradability, which exceed 70%. These results meet limits stipulated by international agreements of EU.

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HODNOCENÍ POVRCHOVÉHO NAPĚTÍ A SEKVESTRAČNÍHO ÚČINKU U PŘIPRAVENÝCH VZORKŮ BIODEGRADABILNÍCH SAMOSEKVESTRUJÍCÍCH TENZIDŮ

Translation of the article

The evaluation of the surface activity and sequestration capacity of prepared samples of biodegradable self-sequestering surfactants

Samosekvestrující tenzidy v sobě spojují vlastnosti tenzidu a sekvestračního prostředku. Tyto látky se pak používají k výrobě pracích a čistících prostředků, v procesech zušlechťování, při barvení apod. S ohledem na životní prostředí je žádoucí, aby prostředky vykazovaly také biodegradabilitu.

Práce se zabývá studiem vzorků samosekvestrujících tenzidů připravených reakcí maleinanhydridu s prostředky na bázi mastných alkoholů popř. amidů mastných kyselin. V našem případě se jedná o samosekvestrující tenzidy, kde spojovacím můstkem mezi polární a nepolární částí molekuly je esterová vazba. U těchto produktů byly hodnoceny jejich základní vlastnosti – povrchová aktivita, sekvestrační kapacita a biodegradabilita.

Připravené vzorky vykazovaly dobrou povrchovou aktivitu, porovnatelnou s používaným tenzidem – dodecylsulfátem sodným. Hodnota sekvestrační kapacity nebyla příliš vysoká, ale tento stav byl očekáván vzhledem k tomu, že obsah funkčních skupin nutných k sekvestraci je zde nízký. Biologická odbouratelnost se pohybuje v hodnotách nad 70%, což splňuje limit 60%, který je stanoven mezinárodními dohodami platným v EU.

STUDY OF THE HYDROLYSIS OF REACTIVE DYES

J. Šašková and J. Wiener

Department of Textile Chemistry, Technical University of Liberec
Hálkova 6, Liberec 46117, Czech Republic
jana.saskova@tul.cz

***Abstract**: Reactive dyes are called according the ability to create covalent bond between dyestuff and fibre polymer. The dye can react with hydroxyl groups in dyebath during cellulose dyeing process and lose ability to bond with fibre. The description of behaviour of hydrolysed reactive dye is the main aim of this contribution. Firstly, the ratio between active and hydrolysed dye was determined by the help of liquid chromatography. The presence of hydrolysed dye is evident after 15 minutes from the beginning of dyeing process, at the end of dyeing process is bath composed from hydrolysed dye mainly. Second part is detection of substantivity of hydrolysed dye. Material was dyed in bath contains hydrolysed dye and its uptake was determined by spectrophotometric measuring. Results were compared with of substantive sorption of active dye.*

***Key words:** Reactive dye, hydrolysis, liquid chromatography, substantivity.*

1 INTRODUCTION

Reactive dyes react with textile material through chemical (covalent) bond. Textile material can be cellulosic – contains OH groups (cotton, viscose, e.g.) or material which contains amino groups (wool, polyamide). Cellulosic material (cotton) was used in this study.

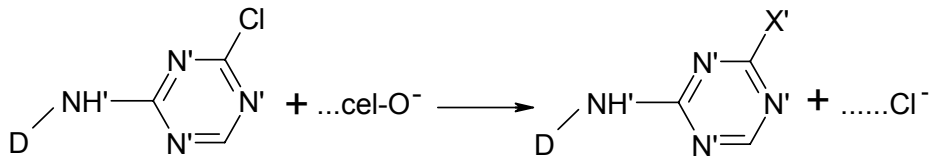
Dyeing process can be divided into two phases.

1) Substantive sorption

Material is putted into bath contain dye and electrolyte. The substantive sorption proceeds only in these neutral conditions – cellulosic chains are not activated and dye diffuse toward the fibre where is absorbed by secondary type forces (by the help of hydrogen bond and Van der Waals forces). These types of forces are typical in case direct dyeing but, molecules of reactive dyes are shorter than molecules of direct dyes, because high substantivity of molecule is not necessary, therefore reactive dyes can provide brilliant shades.

2) Reaction with cellulose

The reaction with cellulosic material started after alkali dosing. Cellulose is transformed to anionic form and attacks the reactive system in dyestuff. Reactive systems can be divided into two main groups depending on mechanism of reaction. [1-3] One part of them react by nucleophilic substitution (e.g. heterocyclic rings contain nitrogen with halogen reactive atoms). The reaction is schematised on monochlortriazine (1).



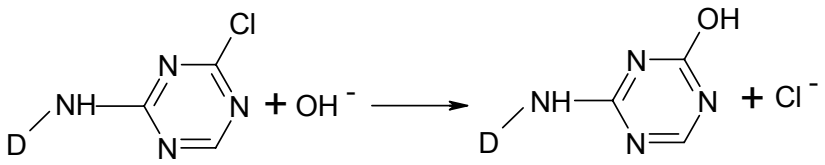
(1)

Dyes based on sulphatoethylsulphone precursor of the vinylsulphone reactive systems (2) react by nucleophilic addition (3)

$$\mathrm{Dye-SO_2CH_2CH_2OSO_3Na} \xrightarrow[-\mathrm{NaHSO_4}]{\mathrm{OH^-}} \mathrm{Dye-S\overset{(-)\delta}{O_2}CH=C\overset{(+)\delta}{H_2}} \qquad (2)$$

$$\mathrm{Dye-S\overset{(-)\delta}{O_2}CH=C\overset{(+)\delta}{H_2}+cel-O^- \xrightarrow{+H^+} Dye-SO_2CH_2CH_2-O-cel} \quad (3)$$

Dye can react with –OH groups in water (4, 5). These reactions proceed simultaneously with dyeing and competed with dyeing process.



(4)

$$\mathrm{Dye-S\overset{(-)\delta}{O_2}CH=C\overset{(+)\delta}{H_2}+OH^- \xrightarrow{+H^+} Dye-SO_2CH_2CH_2-OH} \quad (5)$$

Hydrolysed dye loses ability to form chemical bonding with cellulose, but still can be substantively tied on material by hydrogen bonds and Van der Waals forces. Substantively tied dye causes worse washing fastnesses and after treatment – intensive washing - is necessary. Therefore the hydrolysed dye causes problems, these work was aimed on description of its behaviour.

The degree of hydrolysis – the ratio between active dyestuff (the dye which can react with cellulose) and hydrolysed dye, can be observed by liquid chromatography [4, 5].

The substantivity of hydrolysed dyes can be determined by spectrophotometry using common dyeing process by the help of intentionally hydrolysed dyestuff.

2 EXPERIMENTS

The degree of hydrolysis of two reactive dyes with different reactive groups (mono-chlortriazine - MCHT, sulphatoethylsulphone - SES) was determined by the help of liquid chromatography. The subsatntivity of hydrolysed dye was observed separately.

Samples of reactive dyes were hydrolysed firstly. It is necessary to use strong alkali solution and high temperature to hydrolyse reactive dye. The solution of dye with concentration 10 $g.l^{-1}$ dye, 100 $g.l^{-1}$ Na_2CO_3 (pH 12), was boiled during 90 min. Then the solution was stored for 48 hours at temperature 20°C. Success rate of hydrolysis was tested by thin layer chromatography – by comparison of original dye column with hydrolysed dye column. The solutions of hydrolysed dyes were used like reference solution for liquid chromatography together with solution of “active” dye. Either they were used for demonstration of substantivity of hydrolysed dyes.

2.1 Liquid chromatography

Equipment: Dyeing process – linitest dyeing machine with rotary cartridge heated by water medium. Liquid chromatography - Nova-Pack C18 column with PDA detector and methanol – sodium sulphate solvent (owned by Synthesia Pardubice).

Used dye: C.I. Reactive Orange 16 (sulphatoethylsulphone reactive system – SES); C.I. Reactive Blue 49 (mono-chlortriazine reactive system – MCHT)

Material: nonmercerised cotton, linen weave (140 g/m^2)

The all-in dyeing process was used. It means that all chemicals are added at the start of dyeing. This method was proposed therefore the rate of hydrolysis was tested only.

The experiments proceeded at the following dyeing conditions:

- liquor ratio 1:40,
- additives 10 $g.l^{-1}$ Na_2CO_3, 50 $g.l^{-1}$ NaCl,
- the dosing of dyestuff was 5% o.w.m,
- samples 5g of cotton

Proceeding time was 15, 30, 60 min at temperature 80°C.

The hydrolysis can proceed at alkali condition, therefore the pH must be stabilised to value 7 to stop of process of hydrolysis. The acetic acid (CH_3COOH) was used to reach these neutral conditions. Then the liquid sample was putted into chromatographic column. Chromatograms of dyeings are shown in Figures 1 and 2.

The hydrolysis proceeded in bath without textile material was tested parallely at the same conditions.

2.2 Determination of substantivity of hydrolysed dye

Equipment: Dyeing process – linitest dyeing machine with rotary cartridge heated by water medium. Spectophotometry – Specol 11 by CarlZeiss (Jena)

Used dye: C.I. Reactive Orange 16 (sulphatoethylsulphone reactive system – SES); C.I. Reactive Blue 49 (monochlor-triazine reactive system – MCHT)

Material: nonmercerised cotton, linen weave (140 g/m^2)

Hydrolysed dye was applied at cellulose by this way:

- liquor ratio 1:40
- 50 g.l^{-1} of NaCl
- dosing of dyestuff - 1 %, 3 %, 5% o.w.m.

Proceeding time was 5, 10, 30, 60, 90 min at 80°C. The same recipe was used for observing of substantivity of initial (non-hydrolysed) dyestuff. The uptake of hydrolysed dye was evaluated by spectrophotometric measuring [6] of waste dyebathes.

3 RESULTS AND DISCUSSION

3.1 Liquid chromatography

Chromatograms of dyeing are shown in Figures 1 and 2.

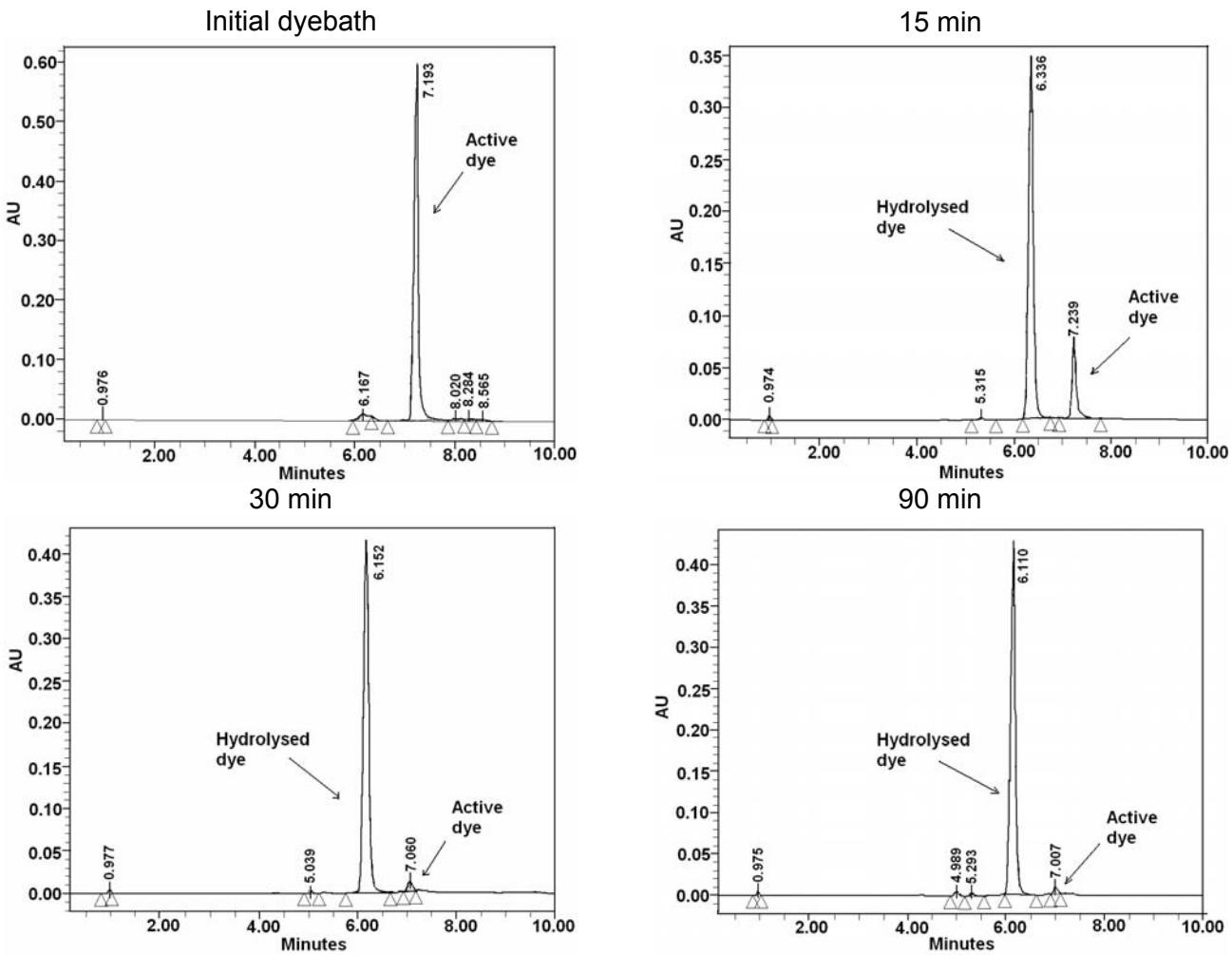


Figure 1 Results of liquid chromatography at the start of dyeing, 15, 30 and 60 min, C. I. Reactive Orange 16

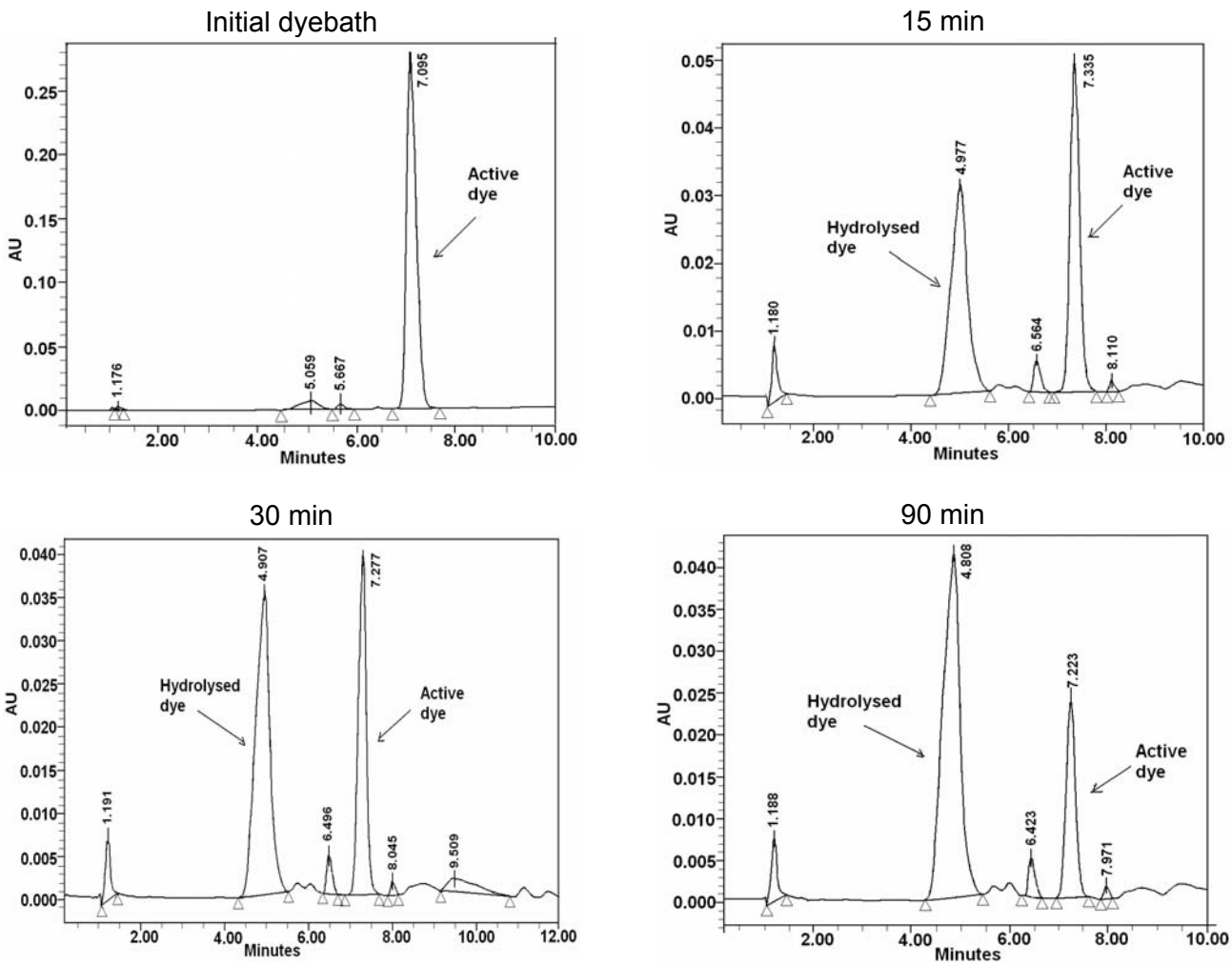


Figure 2 Results of liquid chromatography at the start of dyeing, at 15, 30 and 60 min, C. I. Reactive Blue 49

Results show higher stability of dye bath for C.I. Reactive blue 49. This fact corresponds with characteristic of dye – the reactivity of monochlortriazine is lower than reactivity of vinylsulphonic reactive group contained in C.I. Reactive Orange 16.

The amount of active dye in case of orange coming near zero at the end of dyeing process while amount of active dye is more than 10% in case of blue at the same time. The parallel experiment shows that hydrolysis in bath without textile material is slightly quicker than at normal dyeing.

The percentage of active and hydrolysed dye can be calculated from data obtained from chromatograms – by the comparison of areas under peaks of active and hydrolysed dye (Tables 1 and 2).

Table 1 C.I.Reactive Blue 227, the ratio between active and hydrolysed dye in bath

Time (min)	0	15	30	60	90
Active dye	100%	48%	39%	29%	15%
Hydrolysed dye	0%	52%	61%	71%	85%

Table 2 C.I.Reactive Orange 16, the ratio between active and hydrolysed dye in bath

Time (min)	0	15	30	60	90
Active dye	100%	16%	3%	2%	1%
Hydrolysed dye	0%	84%	97%	98%	99%

3.2 Observing of substantivity of hydrolysed dye

The time dependence of sorption of hydrolysed dye onto cellulose fabric is shown on figs (3, 5), it can be compared with substantive sorption of “initial” dye (4,6).

The dyeing conditions were the same for all experiments. The fact that these experiments proceed at neutral conditions is important. The alkali conditions are necessary to form covalent bonding of dye with cellulose. When we use neutral conditions, the substantive sorption proceed only (the behaviour is the same like at direct dyestuffs – secondary bonding forces take place only). These experiments showed that substantivity of both hydrolysed dyestuffs is comparative with substantivity of active dye in neutral conditions and amount of uptake of hydrolysed dye is not negligible.

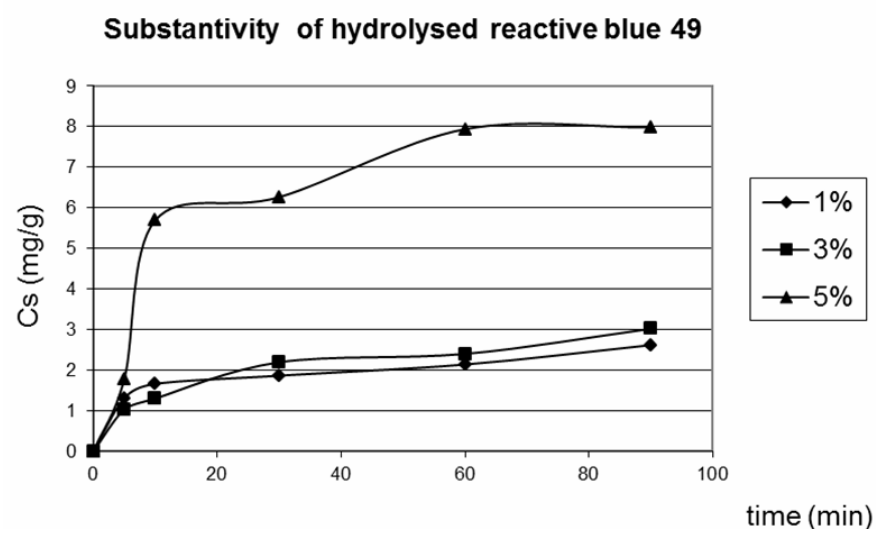


Figure 3 Substantivity of hydrolysed reactive blue 49 – the time dependence of amount of adsorbed dye

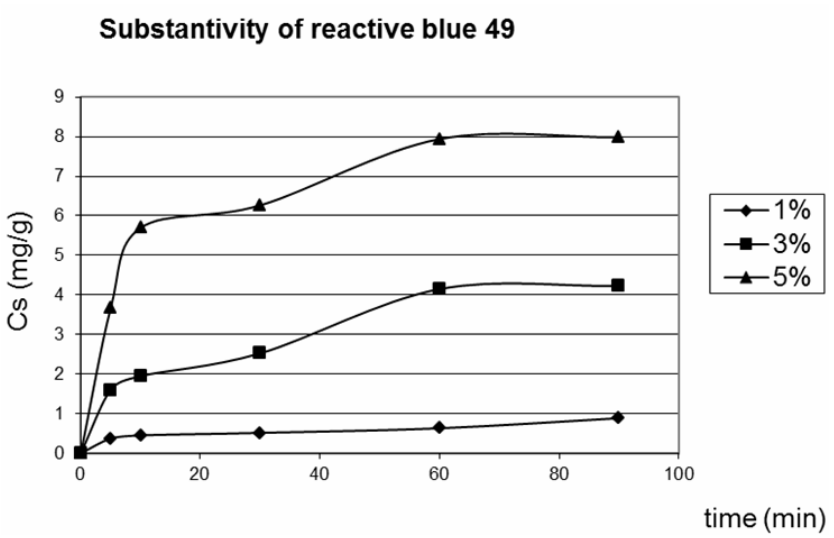


Figure 4 Substantivity of reactive blue 49 - the time dependence of amount of adsorbed dye

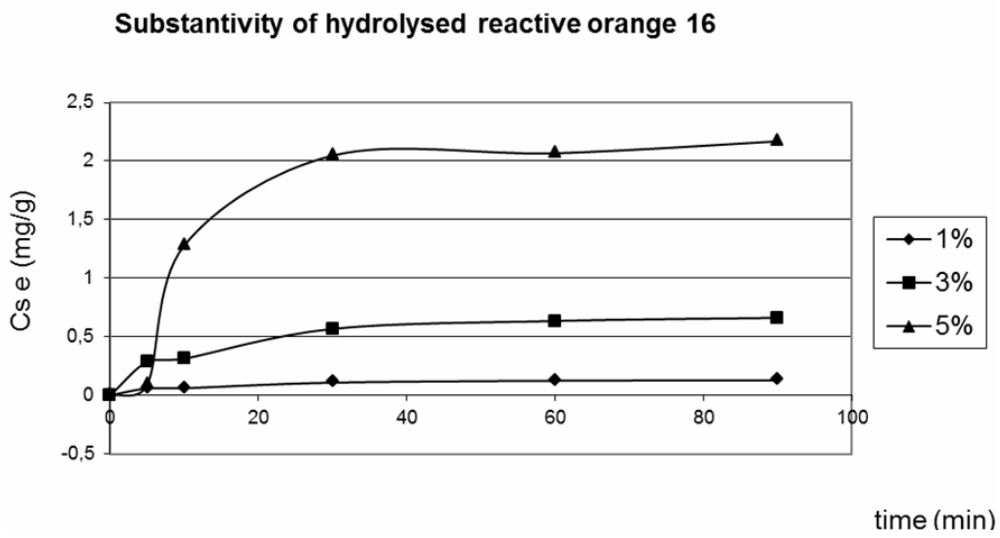


Figure 5 Substantivity of hydrolysed reactive orange 16 - the time dependence of amount of adsorbed dye

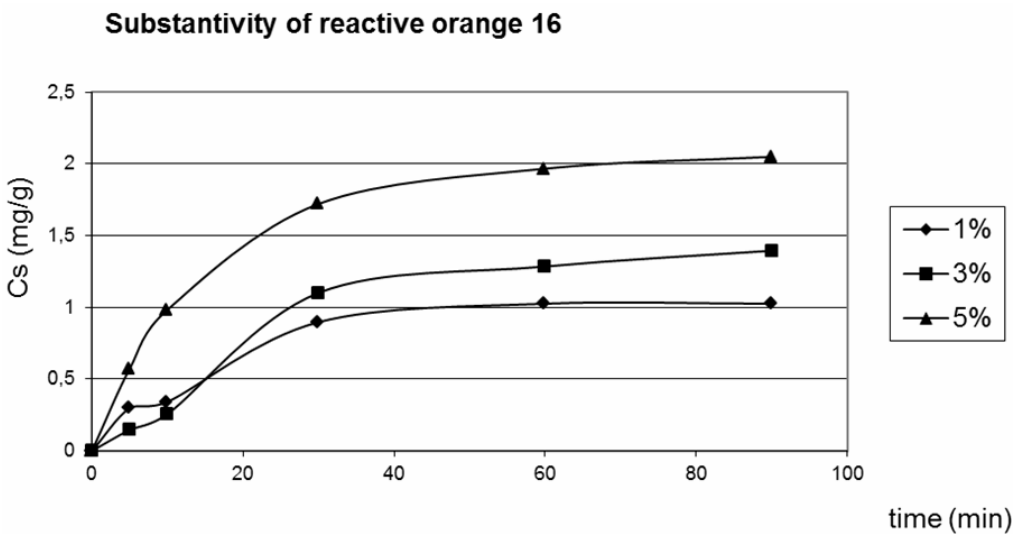


Figure 6 Substantivity of reactive orange 16 - the time dependence of amount of adsorbed dye

4 CONCLUSION

This particle observes behaviour of hydrolysed reactive dye in the time of dyeing. The amount of hydrolysed dye can be determined by chromatography. Two peaks on the chromatograms can be compared, one is active dye, second is hydrolysed dye. It is clear, that amount of active dye on the end of dyeing (90 min) till to zero. Our results show that hydrolysis starts with dyeing process and proceed simultaneously with dyeing process. It corresponds with theory that the reactive dye which has not opportunity in right time to be bonded with material can be immediately hydrolysed.

The observing of substantivity shows that it is depending on type of dye. The substantivity of hydrolysed dye is similar to substantivity of reactive dye in neutral conditions. This fact is important from the producers and customer point of view – the hydrolysed dye weakly bonded by secondary forces (hydrogen and wan der Waals) causes worse wet fastnesses. Therefore intensive washing process must follow the dyeing process.

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SLEDOVÁNÍ HYDROLÝZY REAKTIVNÍCH BARVIV

Translation of the article
Study of the hydrolysis of reactive dyes

Abstrakt: Reaktivní barviva jsou charakterizována vysokými mokrými stálostmi a brilancí odstínů, proto patří v současnosti k nejpoužívanějším barvivům v oblasti barvení celulózy. Reaktivními jsou nazývány díky kovalentní vazbě, kterou tvoří s polymerem, což může být jednak celulóza a rovněž polymery obsahující aminoskupiny, jako vlna a polyamid. Během barvícího procesu barvivo rovněž reaguje s hydroxylovými skupinami v barvící lázni (vodě) a ztrácí tak schopnost reagovat s vláknem prostřednictvím kovalentní vazby. Bohužel substantivita – schopnost sorbovat se na materiál pomocí nevazebných interakcí, jako jsou vodíkové můstky a Van der Waalsovy síly, takovéhoto (myšleno hydrolyzovaného) barviva zůstává zachována a způsobuje zhoršení stálostí finálního vybarvení. Hlavním cílem této práce je popis chování hydrolyzovaného barviva v lázni. Byl sledován stupeň hydrolýzy barviva pomocí kapalinové chromatografie a dále substantivní chování hydrolyzovaného barviva. Z výsledků je patrné, že hydrolýza barviva v lázni začíná krátce po zahájení procesu barvení, na jehož konci zůstává v barvící lázni prakticky jen hydrolyzát. Rychlost hydrolýzy je pro různé typy barviva různá a prakticky koresponduje s jejich reaktivitou. Při sledování substantivity bylo zjištěno, že schopnost hydrolyzátu sorbovat se na materiál je přibližně stejná jako schopnost sorpce daného barviva v neutrálním prostředí. Množství takto sorbovaného barviva může být poměrně velké a vede ke zhoršení mokrých stálostí obarvených výrobků, proto je nutno věnovat velkou pozornost doúpravám po barvení, zejména praní.

WETTABILITY OF COTTON AND WOOL FABRICS AFTER PLASMA TREATMENT

P. Vencelová and A. Ujhelyiová

Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Department of Fibres and Textile Chemistry, Radlinského 9, 812 37 Bratislava, Slovakia
petronela.vencelova@stuba.sk

Abstract: *In this paper the wettability of cotton fabrics as well as desized and sized wool fabrics was investigated. All these samples were treated by low temperature plasma. The wettability was evaluated on the base of contact angles of untreated and treated samples after plasma treatment and different ageing time.*
Keywords: *low temperature plasma, cotton fabrics, wool fabrics, contact angles*

1 INTRODUCTION

Plasma technologies have been utilized to improve the surface properties of fibres in many applications from textiles to fibre-reinforced composites since the 1960´s. Many plasma applications in materials science have been successfully commercialized in the textiles, plastics, or electronics industries [1].

The plasma is defined as an electrically conducting medium generally consisting of negatively charged electrons, positively charged ions, and neutral atoms or molecules or both [1]. The low temperature plasma is a partially ionized gas with electron temperatures much higher than ion temperatures. The high-energy electrons and low-energy molecular species can initiate reactions in the plasma volume without excessive heat causing substrate degradation. It is a versatile technique, where a large variety of chemically active functional groups can be incorporated into the textile surface [3].

Plasma treatment is a nonaqueous and environmentally friendly surface modification technique. Plasma surface modification does not require the use of water and chemicals, so it can be considered as an environmentally benign technology [2, 3]. Application of plasma is ecological and friendly for production costs due to energy savings and reduction of processing times [4].

Plasma is very helpful technique where surface chemical modification is required. Plasma treatment is surface specific method (process), hence it can be employed to modify surfaces without affecting the characteristics of the bulk. Consequently, plasma processes have found a wide range of very important technological applications for modifications of surface energetics to improve adhesion strength, cleaning, coating, wettability, printability, changing physical and/or electrical properties and it is an attractive alternative method to add new functionalities to textiles [3, 5].

In the past decade, a number of conventional methods were adopted to improve the hydrophilicity of the cotton fabrics. Conventional techniques are inherently costly, environmentally unfriendly and this process can treat the fabric bulk. Low temperature plasma treatment was found to be an effective method to improve surface properties without affecting cotton and wool fabric bulk [6].

Plasma treatment can also be used as an effective technique for modifying the surface properties of wool fabric without much alteration of the interior part of the fibre, as the plasma species can penetrate only to a depth of about 1000 Å [7]. By using plasma it is possible to improve shrink resistance of

wool fabric. Plasma treated wool offers a number of processing benefits at different stages of the wool pipeline including improvements in spinning performance and dyeing properties [8].

The wettability (hydrophility, hydrophobicity) is characterized on the base of obtained contact angles which is a important parameter in surface science [9]. Whether the surface is wettable it depends on the value of contact angle. If the contact angle is equal to 0° then the liquid will completely spread over the surface of the solid phase. If the contact angle is equal to 180°, liquid will not wet the solid surface. Generally, the solid surface is called wettable if the contact angle of the liquid drop is less than 90° and is not wettable if the contact angle is higher than 90°. The solid surface may be divided into two groups, they may be hydrophilic (wettable with water) or hydrophobic (not wettable with water). The first case concerns the high-energy surfaces and the second case concerns the low-energy surfaces [10].

In this article the effect of different time of plasma ageing on cotton and wool fabrics was studied. In this paper the wettability will be evaluated on the base of contact angles of untreated and treated samples and for treated samples after different ageing time.

2 EXPERIMENTAL

2.1 Material used

The woven fabrics from the unbleached cotton, the woven fabrics from the sized and desized wool textile with the same structure and weight per unit area as the substrate for the treatment of low temperature plasma were used.

2.2 Methods used

The samples (treated samples) were activated by low temperature plasma generated discharged at the atmospheric pressure for 3 seconds. Ageing time (AT – the time since the plasma treatment till the measurement of contact angle) was 7, 10, 15, 20, 30 and 60 minutes.

The wettability of cotton and wool untreated and treated fabrics was evaluated on the base of measurement of contact angle. Contact angles were measured by using See System (Surface Energy Evaluation System). See System is a portable computer-based instrument consisting of rugged aluminium body, color USB 2.0 camera with 1.3 Mpix resolution movable in vertical direction and 2D horizontally movable table for samples. This measuring system was designed primarily for contact angle measurement.

Liquid drops were dispersed on fabric samples using a micrometer pipette. Water, glycerol and ethylene glycol were used as liquids for measuring contact angles. Liquid drops were placed onto the fabrics surface and pictures were taken in 1 s. Each value of contact angle is the average of 10 measurements. The maximum error of measurement was 4%.This process was used for all samples.

3 RESULTS AND DISCUSSION

The effect of plasma treatment and influence of ageing time (AT) on the wettability of unbleached cotton and sized or desized wool textile fabrics was studied by measuring of their contact angles. The obtained results are listed in the next tables.

Water, glycerol and ethylene glycol with the various surface energies were used as testing liquids. The water has the highest surface energy 72.75 $mN.m^{-1}$, glycerol has 64.0 $mN.m^{-1}$ and ethylene glycol energy has the lowest surface energy 47.0 $mN.m^{-1}$.

The obtained contact angles of desized wool fabrics are shown in the Table 1. The contact angles of fabrics after the plasma treatment for three liquids have been lower than the untreated. We can say that contact angle decreases for water and glycerol after 7 min of plasma treatment. The higher times of plasma ageing increase contact angles, but they have not achieved the values of untreated samples. Due to close surface energies of both these liquids we can see the same tendency. Ethylene glycol has much lower surface energy in comparison with

water and glycerol therefore its influence to the contact angle is different. For the ethylene glycol drops the contact angle after the plasma treatment has been reduced after 7 min since treatment in comparison with untreated fabrics. Decreasing of contact angles continued with time increasing till 20 min. The effect of plasma treatment of wool fabrics was reduced with increasing time. It is shown by higher contact angles after the 30 and 60 min since plasma treatment. The reduction effect of plasma treatment is not very important, because the contact angles did not even reach contact angles after 7 min since treatment.

Table 1 Contact angles of desized wool fabrics

AT [min]	Contact angle [°]		
	water	glycerol	ethylene glycol
untreated	124.9	124.4	114.2
7	107.9	111.7	101.9
10	115.4	114.7	101.2
15	108.1	111.2	107.6
20	113.2	111.5	86.8
30	115.7	120.1	96.5
60	113.9	112.8	92.1

The different situation is in the case of the evaluation of contact angles of sized wool fabrics. The results are presented in the Table 2.

Table 2 Contact angle of sized wool fabrics

AT [min]	Contact angle [°]		
	water	glycerol	ethylene glycol
untreated	98.8	121.3	120.9
7	82.5	106.9	85.5
10	93.2	101.7	70.7
15	95.7	100.5	75.8
20	102.5	105.5	80.8
30	99.7	112.6	86.7
60	96.5	116.4	98.4

The contact angles of plasma treated fabrics are lower than untreated samples for all tested liquid. The highest decreasing of contact angle after 7 min since treatment was marked for the water. Next, the effect of plasma treatment decreases with the growth of time since treatment and the contact angle increases and stabilises at the origin value. The contact angles obtained for glycerol decrease to the 15 min since plasma treatment. The longer time since plasma treatment reduces its effect on the level of untreated. Sizing of wool fabrics has the greatest effect to contact angle of ethylene glycol. Contact angle for untreated wool fabric is at the level of glycerol influence. During plasma treatment contact angle falls strongly at 10 min and after that it increases with the time constantly, but it is still much lower than the primary contact angle value.

The efficiency of plasma treatment of sized wool is sufficient to the 15 min since treatment. It is time when the followed finish processes of textile would be finalized. However, the contact angles of treated sized wool fabrics are lower than the contact angles of treated desized wool fabrics measured for all liquids. It can observe that the wettability of sized wool fabrics is higher than wettability of desized ones [9, 10]. The plasma treatment increases chemical reactivity of size spread on the wool fabrics surface and did not provide to attack the wool surface. At the plasma treatment of desized wool fabrics the wool surface was attacked and the increasing of its reactivity is more difficult than of the sized. Next, there were observed the contact angles of unbleached cotton fabrics (Table 3).

Table 3 Contact angle of unbleached cotton fabrics

AT [min]	Contact angle [°]		
	water	glycerol	ethylene glycol
untreated	121.8	124.0	107.8
7	120.8	117.5	104.3
10	123.7	110.5	104.9
15	125.1	117.7	110.7
20	115.5	118.3	107.6
30	121.6	117.1	77.4
60	123.2	115.5	97.6

From obtained results it can be seen that the plasma treatment did not have any influence on the contact angles measured for the water. The minor decreasing of contact angles was obtained using glycerol till 10 min after treatment. Then, the efficiency of treatment has been on the wane. For the

tested liquid ethylene glycol the contact angle after the plasma treatment was decreased and the effect of ageing time was similar to glycerol.

From results in Tables 1, 2 and 3 we can see that after plasma treatment the difference between contact angles of untreated and treated wool fabrics are higher than difference between contact angles of untreated and treated cotton fabrics. This can signify that the sizing could have positive influence to increase of hydrophility of wool fabrics. After plasma treatment the contact angles for desized and sized wool materials decreased what it indicates that the surface free energy was increased. It can be explained due to creation of oxygen containing functional groups on the surface of fabrics. These groups are very important for increasing wettability and hydrophility of textile surface which would provide to improve the finish processes [6].

4 CONCLUSION

Cotton fabrics surface is similar by hydrophobic as wool desized fabrics and less hydrophilic as sized wool fabrics. The hydrophility of cotton fabrics after plasma treatment did not increase what means that plasma treatment does not have influence to improvement of wettability of cotton materials. Plasma has better influence for changing hydrophility of wool textiles compared to cotton fabrics. The obtained values of contact angles show higher hydrophility of sized untreated wool fabrics compared with desized fabrics. After plasma treatment better wettability was obtained for sized wool fabrics.

Acknowledgement: *This work was supported by the Slovak Research and Development Agency under the contract No. VMSP-P-014-09.*

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ZMÁČATEĽNOSŤ BALNENÝCH A VLNENÝCH TEXTÍLIÍ PO ÚPRAVE PLAZMOU

Translation of the article
Wettability of cotton and wool fabrics after plasma treatment

Abstrakt: Článok sa zaoberá zmáčateľnosťou bavlnených, ako aj odšlichtovaných a šlichtovaných vlnených textílií. Všetky vzorky boli upravené nízkoteplotnou plazmou. Zmáčateľnosť bola hodnotená pomocou kontaktných uhlov meraných na plazmou neupravených vzorkách a taktiež na plazmou upravených vzorkách pri rôznych časoch starnutia plazmy.

60. VÝROČIE ZALOŽENIA VÝSKUMNÉHO ÚSTAVU CHEMICKÝCH VLÁKIEN, a.s. VO SVITE

V. Jašová

Výskumný ústav chemických vlákien, a.s., Štúrova 2, 05921 Svit, Slovenská republika

Výskumný ústav chemických vlákien vo Svite bol založený 1. januára 1951 ako sektorový ústav na základe celospoločenskej potreby vybudovať vlastnú vedeckovýskumnú a technologickú základňu pre výskum, vývoj a výrobu chemických vlákien v bývalom Československu. Ústav vznikol rozdelením pôvodnej Baťovej továrne založenej vo Svite v roku 1934, na 3 nástupnícke podniky – Chemosvit, n.p., Tatrasvit, n.p. a v tom čase Výskumný ústav umelých vlákien.

Z ústavu, ktorý svoju činnosť začínal v provizórnych laboratóriách s 26 pracovníkmi vyčlenenými z Chemosvit, n.p., postupne vyrástla výskumná ustanovizeň, ktorá svojom činnosťou významne prispela k rozvoju výroby chemických vlákien v bývalom Československu.

V prvých rokoch existencie ústavu bola jeho činnosť zameraná na racionalizáciu existujúcich výrob chemických vlákien. Po postupnom personálnom a materiálno-technickom dobudovaní začal VÚCHV riešiť výskumné úlohy spojené s plnením dôležitých investičných zámerov, ktorých cieľom boli kompletné projekčné podklady pre zavedenie nových výrob chemických vlákien.

Od roku 1955 bol ústav poverený riešením prípravy viskózových kordových vlákien, ktoré boli v tomto období dovážané zo zahraničia pre potreby gumárenského priemyslu. Po uvalení embarga na túto strategickú surovinu, VÚCHV technológiu prípravy viskózových kordových vlákien vyriešil a výsledky úspešne realizoval. V Československu bola výroba kordových vlákien realizovaná v Rudníku a v Lovosiciach, v zahraničí v Pirne (bývalá NDR) a v Tomaszove (Poľsko).

V oblasti celulózových vlákien ústav v nasledujúcom období zabezpečoval výskum technológie a vývoj strojného zariadenia pre kontinuálnu výrobu viskózového textilného hodvábu, realizovanú v a.s. Slovenský hodváb, Senica.

Významný podiel výskumnej činnosti VÚCHV tvoril výskum v oblasti prípravy syntetických vlákien - polyamidových, polyesterových a polypropylénových ako aj výskum netradičných postupov prípravy vláknitých materiálov zo syntetických polymérov.

V oblasti polyamidových (PA) vlákien bola pre potreby Chemlon, a.s., Humenné riešená a realizovaná výroba PA6 technického a kordového hodvábu na dĺžiaco-skacích strojoch z vývoja VÚCHV, a.s., realizovaná výroba textilného hodvábu s antistatickou úpravou v hmote a zavedená výroba PA káblika pre potlač. Úspešne boli realizované výsledky riešenia diskontinuálnej technológie výroby káblikov v Chemosvit, a.s. Svit a v Chemlon, a.s. Humenné. Pre výrobu káblikov bola vyriešená technológia farbenia injekčným spôsobom, ktorá vo svetovom meradle v danom čase predstavovala unikátne riešenie.

V oblasti polyesterových (PES) vlákien bol v Silon, n.p., Planá nad Lužnicí na základe podkladov VÚCHV úspešne realizovaný nový sortiment PES strižových vlákien a realizované farbenie vo hmote. V a.s. Slovenský hodváb, Senica pracovníci VÚCHV rozšírili sortiment PES textilného hodvábu a zaviedli farbenie textilného hodvábu v hmote.

Najväčšiu pozornosť ústav venoval výskumu technológii prípravy a vývoju strojného zariadenia pre výrobu polypropylénových vlákien všetkých typov. Postupne od roku 1965 bola na podkladoch VÚCHV realizovaná výroba cca 48 tis. ton PP vlákien. Vysoké objemy výroby PP vlákien boli zabezpečované pre potreby štátov bývalej RVHP.

Po roku 1989 bol VÚCHV nútený prehodnotiť svoju činnosť. Zánik RVHP, v dôsledku čoho došlo k podstatnému zníženiu objemu výroby chemických vlákien v Čechách a na Slovensku a zmena ekonomických podmienok v spoločnosti, negatívne ovplyvnili realizačné aktivity podnikov, financovanie výskumnej činnosti a v konečnom dôsledku aj aktivity ústavu. Ak chcel ústav toto kritické obdobie prežiť, musel popri obmedzenej výskumnej činnosti rozšíriť výrobnú činnosť, pre ktorú boli využité dlhoročné poznatky a skúseností z vlastného výskumu a vývoja a existujúce strojno-technologické vybavenie.

Nevyhnutné investície do strojného vybavenia malotonážnych výrob koncentrátov aditív, PP strižových vlákien a technického hodvábu a tiež do výroby strojných zariadení zabezpečili konkurencieschopnosť týchto výrobkov na domácom i zahraničnom trhu.

Pôsobnosť ústavu bola následne rozšírená aj o oblasť skúšobníctva. VÚCHV, a.s. je držiteľom osvedčení o akreditácii skúšobných laboratórií a certifikačného orgánu certifikujúceho výrobky zo strany Slovenskej národnej akreditačnej služby. Úrad pre normalizáciu, metrológiu a skúšobníctvo SR autorizoval VÚCHV, a.s, ako notifikovanú osobu NO 1634 pre oblasť skúšania textilných hračiek.

V záujme udržania zákazníkov ústav už v roku 1998 zaviedol systém manažérstva kvality podľa normy ISO 9001 a v roku 2000 bol spoločnosti udelený certifikát na systém environmentálneho manažérstva podľa normy ISO 14001. Ústav nad rámec toho deklaruje, že venuje trvale veľkú pozornosť ochrane životného prostredia, dôkazom čoho je aj udelenie certifikátu v roku 2010 za splnenie podmienok programu Zodpovedná starostlivosť – tzv. Responsible Care.

Na základe hodnotenia realizačných aktivít ústavu je možné konštatovať, že na podkladoch VÚCHV bolo za uplynulých 60 rokov činnosti realizovaných viac ako 100 výstupov väčšieho i menšieho rozsahu v oblasti technológií výrob chemických vlákien a zhruba 17 realizácií strojných zariadení určených pre výrobu celulózových a syntetických vlákien. Až 45 aktivít však bolo realizovaných vo výrobe polypropylénových vlákien. Do tejto skupiny sa v posledných 7 rokoch radí aj intenzívna spolupráca so spoločnosťou Chemosvit Fibrochem, a.s., kde sa ústav významnou mierou podieľa na modernizácii existujúcich výrob s dôrazom na kontinuálny vývoj a výrobu 8-miestnych kompaktných liniek, určených na výrobu stredne a mikrovláknitého polypropylénového POY hodvábu farbeného v hmote.

Okrem realizovaných výsledkov, významnou oblasťou propagácie práce ústavu bola činnosť vynálezcovská a publikačná. Počas doterajšej histórie bolo jeho pracovníkom udelených vyše 470 patentov a autorských osvedčení a počet publikácií sa odhaduje na zhruba 1160 prác.

Výskumná činnosť vo VÚCHV v posledných rokoch aj naďalej klesá, v súčasnosti tvorí len okolo 6% výkonov. Tento negatívny stav je ovplyvnený predovšetkým nedostatkom prostriedkov na financovanie výskumu a vývoja zo strany hospodárskej sféry aj štátu, ale aj veľkou konkurenciou chemických vlákien a textilných výrobkov dovážaných z Ázie, ktoré postupne európske vláknarenské spoločnosti vytláčajú z trhu.

Súčasný výskum vo VÚCHV je orientovaný najmä na rozšírenie sortimentu PP vlákien, farebných koncentrátov pre farbenie syntetických vlákien v hmote, ale aj koncentrátov aditív pre dosiahnutie požadovaných funkčných vlastností. Prebiehajúce výskumné aktivity okrem iného zahŕňajú účasť ústavu na riešení medzinárodného projektu 7. Rámcového programu EÚ s názvom SAFEPROTEX, ktorého cieľom je vývoj ochranných odevov s niekoľkonásobnými bariérovými vlastnosťami, určených pre pracovníkov záchranných zložiek.

V predchádzajúcom období sa ústav zaoberal dnes už nevyhnutnou problematikou biopolymérnych systémov, resp. vlákien, ktoré sú šetrné k životnému prostrediu a sú v prírode odbúrateľné. V roku 2011 bol v tejto oblasti ukončený projekt BIOVLATEX, spolufinancovaný Agentúrou na podporu výskumu a vývoja SR.

Okrem rezortných inštitúcií, ústav pri riešení výskumných úloh úzko spolupracoval aj s akademickou sférou na Slovensku a v zahraničí, v súčasnosti najmä s Fakultou chemickej a potravinárskej technológie, Slovenskej technickej univerzity v Bratislave a jej Ústavom polymérnych materiálov. Medzi ďalších partnerov v tejto oblasti patria výskumné ústavy a organizácie hospodárskej sféry, ako napríklad VÚTCH–CHEMITEX, s.r.o., Sintex, a.s., Silon, s.r.o., Nexis Fibers, a.s., Slovnaft, a.s., Pegas, a.s., BASF, s.r.o., Precolor, o.z. a mnohí ďalší.

Príkladom veľmi úzkej spolupráce a úspešného dotiahnutia zámeru výskumnej úlohy do finálneho výstupu, ktorý sa dostáva do rúk spotrebiteľovi je aj vývoj antimikrobiálneho PP vlákna na báze striebra, aplikovaného v mnohých domácich a zahraničných textilných výrobkoch. V tomto prípade sa na koncovom produkte podieľali spoločnosť VÚTCH-CHEMITEX, s.r.o. zo Žiliny, ako dodávateľ antimikrobiálneho prípravku Biostat, ďalej VÚCHV, a.s. Svit v časti prípravy funkčného koncentrátu a nakoniec výrobca aditivovaného vlákna a z časti aj finalizovaných ponožiek, spoločnosť Chemosvit Fibrochem, a.s.

Súčasná výrobná činnosť ústavu spočíva vo výrobe polypropylénových strižových vlákien, farebných koncentrátov a koncentrátov aditív a vo výrobe strojných zariadení. Viac ako 40% celkového objemu výroby predstavuje vývoz do Českej republiky, Poľska, Ruska, Ukrajiny, Lotyšska a Talianska.

Za uplynulých 60 rokov sa o vedenie VÚCHV, a.s. vo funkcii generálneho riaditeľa zaslúžili 10 pracovníci:

1951 – 1955 Ján Martinovič
1955 – 1960 Ing. Ján Matis
1960 – 1969 Prof. Ing. Martin Jambrich, DrSc.
1969 – 1970 Ing. Pavol Hrivnák
1970 – 1974 Prof. Ing. Martin Jambrich, DrSc.
1974 – 1985 Ing. Ivan Diačik, DrSc.
1986 – 1992 Ing. Rudolf Šimo, CSc.
1992 – 1993 Ing. Radoslav Lackovič
1993 – 2007 RNDr. Dušan Budzák
2007 – 2010 Ing. Tibor Varga

Od 1. októbra 2010 je vo funkcii generálneho riaditeľa ústavu Ing. Martin Budzák.

K smerovaniu a k rozvoju VÚCHV, a.s. svojou tvorivou činnosťou prispievali aj mnohí vedúci, ale aj radoví pracovníci na všetkých úsekoch jeho činnosti.

Pri príležitosti 60. výročia založenia Výskumného ústavu chemických vlákien, a.s. sa 8.9.2011 uskutočnilo vo Svite stretnutie obchodných a výskumných partnerov VÚCHV, a.s. Svit.

Vo svojom príhovore k pozvaným hosťom generálny riaditeľ Ing. Martin Budzák vyzdvihol výsledky doterajšej spolupráce na všetkých úsekoch činnosti ústavu a poďakoval partnerom za prejavenú dôveru.

Uviedol, že v celom rozsahu činností VÚCHV, a.s. mali vždy dôležitú úlohu spolupracujúce organizácie a obchodní partneri, ktorí tvorili hnaciu silu k hľadaniu riešení a k uskutočňovaniu všetkých potrebných zmien v spoločnosti. Uistil všetkých prítomných, že VÚCHV, a.s. bude aj naďalej organizáciou vyznávajúcou zásady spoločenskej zodpovednosti v podnikaní, za ktorú budú hovoriť jej výsledky a spokojnosť zákazníkov.

Zo strany prítomných zástupcov partnerských organizácií VÚCHV, a.s. k jeho jubileu postupne zablahoželali: Ing. Roman Karlubík, MBA (prezident ZCHFP), Ing. Michal Ľach (generálny riaditeľ Chemosvit, a.s. Svit), Phdr. Rudolf Abraham (primátor mesta Svit), Ing. Jozef Šesták, CSc. (riaditeľ VÚTCH-CHEMITEX, s.r.o. Žilina), Ing. Jozef Kochan (riaditel Chemosvit Fibrochem, a.s. Svit), Prof. Viktor Milata (predseda Slovenskej chemickej spoločnosti). Všetci jubilantovi do ďalších rokov zaželali veľa tvorivých nápadov a úspechov.

Súčasťou stretnutia bol aj krst knihy „História rozvoja chemických vlákien na Slovensku“, ktorej autormi sú Prof. Ing. Martin Jambrich, DrSc., bývalý riaditeľ VÚCHV, a.s., Prof. Ing. Viktor Milata, DrSc., Ing. Miloš Révus a Prof. Ing. Michal Uher, DrSc. Kniha bola vydaná ako 7. zväzok cyklu „Chemický priemysel v zrkadle dejín Slovenska“.

Referencie

1. Príhovor generálneho riaditeľa VÚCHV, a.s. Ing. M. Budzáka na stretnutí výskumných a obchodných partnerov uskutočneného pri príležitosti 60. výročia založenia VÚCHV, a.s. Svit
2. História jednej myšlienky, kol. autorov, monografia mesta Svit vydaná pri príležitosti 75. výročia jeho vzniku