

Izvirni znanstveni članek *Original Scientific Paper*

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Elementarno srebro nano delcev kot antibakterijsko sredstvo na bombažni tkanini *Elementary nano sized silver as antibacterial agent on cotton fabric*

Pripravljena je bila protimikrobna apretura z uporabo elementarnega srebra velikosti delcev nano dimenzij brez in v kombinaciji anorganske oksidne matrice. Apertura je bila nanesena na bombažno tkanino v šestih koncentracijah srebra od 0,01 do 0,5 % na maso blaga po izčrpalnem postopku, izvedenem v Launder-ometru. Zamreženje matrice je bilo doseženo toplozračno. Morfološke lastnosti aperturnega filma so bile določene s SEM, njegova sestava pa s FT-IR in EDXS analizo. Koncentracija Ag na tkanini je bila določena z ICP-MS. Bakterične lastnosti aperture so bile določene na podlagi meritev bakterijske redukcije za bakterijsko vrsto *Escherichia coli*. Določen je bil vpliv aperture na spremembo beline tkanine, njene svetlobne obstojnosti, omočljivost, togost in zračno prepustnost. Iz rezultatov raziskave je bilo razvidno, da se je z naraščajočo koncentracijo Ag v aperturni kopeli povečevala tudi koncentracija Ag na tkanini, ki se je v prisotnosti oksidne matrice še povečala. Bakterijska redukcija se z naraščajočo koncentracijo Ag na tkanini ni bistveno spremenila. V vseh primerih, tudi pri najvišji koncentraciji Ag je ostala nižja od 60 %, kar je pomenilo nezadovoljivo bakterično delovanje. Prisotnost oksidne matrice v aperturi je še poslabšala njene bakterične lastnosti. Medtem ko nanos srebra ni bistveno spremenil omočljivosti tkanine, se je le-ta povečala pri vzorcih apretiranih s kombinacijo srebra in oksidne matrice. Prisotnost aperture je na splošno vplivala na znižanje beline tkanine, ki se je z osvetljevanjem vzorcev z umetno svetlobo še poslabšala. Oksidna matrica v aperturi je povzročila rahlo zmanjšanje zračne prepustnosti tkanine, zmanjšala pa je tudi togosti tkanine v primerjavi s tkanino, apretirano le s srebrom.

Ključne besede: antibakterijska apertura, elementarno srebro, oksidna matrica, bombažna tkanina, bakterijska redukcija, belina, omočljivost, fizikalne lastnosti.

Antimicrobial finish was prepared by the use of elementary silver of nano dimensions, without and with a combination of anorganic

*oxide matrix. Finish was applied on cotton fabric in six different concentration of silver, ranging from 0.01 to 0.5 % on fabric mass. Application was performed by the exhaustion method using Launderometer. Network formation of the matrix was obtained by worm air. Morphological properties of the coating film were studied by SEM, while its composition by FT-IR and EDXS analysis. Concentration of silver was determined by ICP-MS. Bactericidal properties were quantitatively studied in terms of bacterial reduction for bacterium *Escherichia coli*. Influence of finish on whiteness of the fabric, light fastness, wettability, stiffness and air permeability was studied as well. The results showed that by increasing Ag concentration in the finishing bath, the concentration of Ag on textile increased as well, while it further increased in the presence of oxide matrix. However, the bacterial reduction did not significantly change by the increase of Ag concentration and stayed below 60 % in the case of all studied concentrations, even at the highest one, showing insufficient bactericidal activity. The presence of the oxide matrix, further decreased its antibacterial properties. While application of silver did not significantly influenced the wettability of the fabric, latter increased on the samples treated by a combination of silver and oxide matrix. In general, application of finish influenced on a decrease of whiteness of the fabric, which further decreased by illuminating the samples with an artificial light. The presence of oxide matrix in the finish caused slight decrease of air permeability of the fabric, compared to the air permeability of the fabric where only silver was applied.*

Key words: antibacterial finish, elementary silver, oxide matrix, cotton fabric, bacterial reduction, whiteness, wettability, physical properties.

Pregledni znanstveni članek *Review*

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Mikrokapsuliranje na področju tekstilstva *Microencapsulation in textiles*

Prispevek opisuje proces, najpomembnejše tehnologije in uporabo mikrokapsuliranja v tekstilni industriji. Uporaba mikrokapsul ne-nehno narašča, še posebej v tekstilnih industrijah zahodne Evrope, na Japonskem in v Severni Ameriki. Kljub široki uporabi v industriji pa mikrokapsuliranje ostaja ljudstvu večinoma neznan proces. Je cenovno primerna in dolgotrajna metoda za shranjevanje hitro hlapljivih snovi. Mikrokapsule so primerne za mnoge izdelke. Ti proizvodi imajo različne lastnosti, ki so odvisne od narave kapsuliranih snovi. Nekateri so opisani v tem prispevku, na primer izdelki s PCM- materiali, dezodorantskimi apreturami, protimikrobnimi apreturami, ognjevarnimi apreturami, sistemom spreminjanja barve itd.

Ključne besede: mikrokapsuliranje, nadzorovano sproščanje, tekstil, tehnologije, apreture

This paper describes current processes, technologies and applications related to microencapsulation in the textile industry. The use of microencapsulation continues to grow especially in the textile industries of Western Europe, Japan, and North America. Although it is widely used in industry, microencapsulation remains relatively unknown to the public. It is a cost-effective method for storing volatile substances over a long period of time. Microcapsules are available for a wide range of products. These products are given various properties related to the nature of the encapsulated substances. Some of these are described in this paper, including products with phase-change properties, fragrance finishes, antimicrobial finishes, fire retardants, color-change properties and color formers.

Key words: microencapsulation; controlled release; textile; technologies; finishes

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Nizko hranljivi medij izboljša določitev fungicidnega delovanja AgCl na celuloznih vlaknih

A low nutrition medium improves the determination of fungicidal activity of AgCl on cellulose fibres

Namen raziskave je bil določiti fungicidne lastnosti protimikrobne apreture, pripravljene iz AgCl v kombinaciji z reaktivnim vezivom na podlagi silicijeve spojine, na celuloznih vlaknih. Nanos apreture na bombažno tkanino je bil izveden po izčrpalnem postopku. Sledili so ožemanje, sušenje in kondenziranje tkanine, pri čemer je poteklo zamreženje reaktivnega veziva. Vpliv apreture na morfološke lastnosti tkanine je bil preučevan z vrstično elektronsko mikroskopijo, koncentracija srebra na apretiranem vzorcu pa je bila določena z masno spektrometrijo z vzbujanjem v induktivno sklopljeni plazmi. Fungicidni test je bil izveden po standardu DIN 53931 na ploščah s trdnim MEA-gojiščem, obogatanim z dodatkom ovsenih kosmičev, za glivi *A. niger* in *C. globosum*. Visoko hranilno MEA-gojišče z ovsenimi kosmiči, ki ga predpisuje standardna metoda, je manj primerno za preučevanje toksičnosti srebra v apreturi na bombažni tkanini za uporabljeni glivi. To je vodilo do modifikacije standardne metode in uporabe manj hranilnega SNA-gojišča. AgCl, dodan v SNA, učinkovito zavre rast obeh pre-

učevanih gliv. Toksično deluje tudi v apreturi na bombažni tkanini pri uporabljeni koncentraciji 130 ppm. AgCl je učinkovitejši fungicid za glivo *C. globosum* kot za *A. niger*. Rast glive *C. globosum* v celoti zavre, medtem ko micelij glive *A. niger* prerase gojišče pod apretiranim vzorcem.

Ključne besede: celuloza, srebrov klorid, protimikrobna apretura, fungicidna aktivnost, vpliv gojišča

*The fungicidal characteristics of an anti-microbial finish on cellulose fibres based on AgCl in combination with a reactive, silicon-based organic-inorganic binder was determined. The finish was applied to the cotton fabric by the exhaustion method, followed by wringing, drying and condensation of the fabric to achieve a cross linking of the reactive binder. The influence of the finish on the morphological characteristics of the fabric was studied by scanning electron microscopy. The silver concentration on the coated sample was determined by the inductively coupled plasma mass spectroscopy. The fungicide test was carried out for the fungi *Aspergillus niger* and *Chaetomium globosum* according to the DIN 53931 standard method with the use of malt extract agar (MEA) culture medium enriched by oat-meal. The results showed that MEA enriched by oat-meal is inappropriate medium for determining the toxicity of the silver coating on cotton fabric, due to its high nutritious value, which caused intensive overgrowth of the studied fungi, making the evaluation of antifungal activity impossible. Therefore, the synthetic nutrient-poor agar (SNA) culture medium was used instead. When mixed into SNA, AgCl inhibited the growth of both studied fungi efficiently. At the concentration of approximately 130 ppm, AgCl was also toxic in the coating on the cotton fabric, suppressing the growth of *Chaetomium globosum* more efficiently than *Aspergillus niger*.*

Key words: cellulose, silver chloride, antimicrobial finishing, fungicidal activity, influence of culture medium