

WE ARE *live* IN

Veli Lošinj



27th CROATIAN MEETING OF CHEMISTS AND CHEMICAL ENGINEERS

WITH INTERNATIONAL PARTICIPATION • 5th SYMPOSIUM "VLADIMIR PRELOG"
5-8 OCTOBER 2021 • VELI LOŠINJ, HOTEL PUNTA, CROATIA

BOOK OF ABSTRACTS

27th Croatian Meeting of Chemists and Chemical Engineers

with international participation

5th Symposium Vladimir Prelog

5 – 8 October 2021

Veli Lošinj, Vitality Hotel Punta, Croatia

BOOK OF ABSTRACTS

SCIENTIFIC AND ORGANISING COMMITTEE

Dean Marković, *Chair*, University of Rijeka

Ernest Meštrović, *Co-chair*, Xellia d.o.o.

Vesna Tomašić, *Co-chair*, Faculty of Chemical Engineering and Technology, University of Zagreb

Senka Djaković, *secretary*, Faculty of Food Technology and Biotechnology, University of Zagreb

Zrinka Buhin Šturlić, Medic d.o.o.

Igor Dejanović, Faculty of Chemical Engineering and Technology, University of Zagreb

Stjepan Džalto, Hidroplan d.o.o.

Zvezdana Findrik Blažević, Faculty of Chemical Engineering and Technology, University of Zagreb

Vesna Gabelica Marković, Faculty of Chemical Engineering and Technology, University of Zagreb

Nenad Judaš, Faculty of Science, University of Zagreb

Olgica Martinis, Education and Teacher Training Agency

Danijel Namjesnik, Faculty of Science, University of Zagreb

Jasna Prlić Kardum, Faculty of Chemical Engineering and Technology, University of Zagreb

Silvana Raić Malić, Faculty of Chemical Engineering and Technology, University of Zagreb

Marko Rogošić, Faculty of Chemical Engineering and Technology, University of Zagreb

Marin Roje, Ruđer Bošković Institute, Zagreb

Aleksandra Sander, Faculty of Chemical Engineering and Technology, University of Zagreb

Vladislav Tomišić, Faculty of Science, University of Zagreb

Andrea Usenik, Faculty of Science, University of Zagreb

Mario Vazdar, Ruđer Bošković Institute, Zagreb

Nikola Bregović, Faculty of Science, University of Zagreb

INTERNATIONAL SCIENTIFIC COMMITTEE

Jurica Bauer, Maastricht University, Maastricht, the Netherlands

David Bogle, University College London, London, UK

Paweł Dydio, Laboratory of Complex Systems in Synthesis & Catalysis (CosyCAT), Institute of Science and Supramolecular Engineering (ISIS), University of Strasbourg & CNRS, Strasbourg Cedex, France

Tomislav Friščić, McGill University, Montreal, Canada

Janez Plavec, Slovenian NMR Centre, National Institute of Chemistry, Ljubljana, Slovenia

Giovanna Speranza, Department of Chemistry, University of Milan, Milan, Italy

LOCAL ORGANISING COMMITTEE

Sandra Kraljević Pavelić, Gabriela Ambrožić, Maria Kolymjadi Markovic, Tomislav Pavlešić, Alma Ramić

IMPRESSUM

ORGANIZERS

Croatian Chemical Society
Croatian Society of Chemical Engineers

PUBLISHED BY

Croatian Chemical Society

EDITORS

Dean Marković, Ernest Meštrović,
Danijel Namjesnik, Vesna Tomašić

DESIGN & LAYOUT

Danijel Namjesnik & Andrea Usenik

ISSN: 2757-0754 (Online)

VENUE

Veli Lošinj, Vitality Hotel Punta, Croatia
<https://www.losinj-hotels.com/hr/hoteli-i-vile/hotel-punta/>

Zagreb, 2021.

Ivo Piantanida, Ksenija Božinović, Dragomira Majhen, Goutam Kumar Kole, Todd B. Marder, Marta Koščak <i>2- and 2,7-substituted pyridine pyrenes derivatives and their DNA/RNA interactions</i>	85
Magdalena Kralj, Sara Krivačić, Petar Kassal, Antonio Supina, Željka Boček, Ivan Halasz <i>Avenue to facile medium-scale production of graphene quantum dots and graphene nanosheets.....</i>	86
Ana Alebić-Juretić, Boris Mifka <i>Airborne desert dust in the northern Adriatic area (Croatia): different sources</i>	87
Sarah Mateša, Irena Ciglencečki <i>Application of the electrochemical method for monitoring polysulfides (S_x) in marine euxinic environment (Rogoznica lake, Croatia).....</i>	88
Mario Špadina, Atiđa Selmani, Bertrand Siboulet, Davor Kovačević, Goran Dražić, Jean-Francois Dufreche, Klemen Bohinc <i>Revising solute adsorption models in the case of loose TiO₂ nanotubes surfaces.....</i>	89
Iva Rezić <i>Investigation of allergenic metals on fashion accessories and decorative metallized yarns</i>	91
Luka Pavić, Stjepko Fazinić, Hüseyin Ertap, Mevlüt Karabulut, Andrea Moguš-Milanković, Ana Šantić <i>Model-free scaling of conductivity spectra: insight into electrical transport in iron phosphate-based glasses</i>	92
POSTERS	
Chemistry	
Maša Buljac, Ivana Škugor Rončević, Nives Vladislavić, Marijo Buzuk <i>Electrochemical behavior of natural reducers on carbon nanomaterials: a contribution to the optimization of electroanalytical methods.....</i>	94
Ivana Škugor Rončević, Nives Vladislavić, Boris-Marko Kukovec, Marijo Buzuk, Maša Buljac <i>Transition metal coordination polymers: synthesis, spectroscopic and electrochemical studies</i>	96
Ivana Vrca, Vedrana Čikeš Čulić, Ivica Blažević, Tea Bilušić <i>The influence of the black mustard sample preparation method on chemical composition, antiproliferative and proapoptotic effects</i>	97
Dajana Gašo-Sokač, Valentina Bušić, Maja Molnar <i>An eco-friendly preparations of izonicotinamide quaternary salts in deep eutectic solvents.....</i>	99
Robert Kerep, Tino Šeba, Tin Weitner, Mario Gabričević <i>Evaluation of thermodynamic parameters between antidepressant imipramine and human α1-acid glycoprotein by isothermal titration calorimetry.....</i>	100
Kristinka Vinković, Danijela Ašperger, Bruna Babić, Gabrijela Priščan <i>Determination of pseudoestrogenic compounds in thermochromic printing ink</i>	101
Josip Radić, Marija Bralić, Maša Buljac, Marina Šola <i>Potentiometric response characteristics of carbon paste electrode for maprotiline determination.....</i>	102
Antonela Ninčević Grassino, Sara Spalj, Tomislav Bosiljkov <i>Evaluation of pectin biofilms with incorporated phenolic extracts of “karoma” spent espresso coffee grounds</i>	103
Antonela Ninčević Grassino, Sara Spalj, Iva Sušić, Marina Šango <i>Microwave-assisted extraction of polyphenols from coffee (green and roasted) and its by-products (silver skin and spent coffee ground)</i>	104
Armands Sebris, Kaspars Traskovskis, Irina Novosjolova, Māris Turks <i>Synthesis and photophysical properties of purine-carbazole donor acceptor systems.....</i>	105

Mirna Habuda-Stanić, Huiyu Dong, Antonija Kristek Janković <i>Structural characterisation of modified bioadsorbents</i>	348
Kristijan Vidović, Samo Hočevar, Irena Ciglencečki-Jušić <i>A new approach for studying adsorption processes on solid electrodes in seawater conditions</i>	349
Karla Plenča, Andrea Opačak, Sara Cvetković, Matija Cvetnić, Ana Lončarić Božić, Zvonimir Matusinović, Hrvoje Kušić <i>Laboratory pyrolysis of biomass: gas product analysis</i>	351
Andrea Opačak, Karla Plenča, Sara Cvetković, Matija Cvetnić, Tomislav Bolanča, Ana Lončarić Božić, Zvonimir Matusinović, Hrvoje Kušić <i>Optimization of biomass pyrolyzation on laboratory pyrolysis system</i>	352
Irena Ciglencečki, Ivica Vilibić, Jelena Dautović, Niki Simonović, Vjeročka Vojvodić, Božena Čosović, Petra Zemunik, Natalija Dunić, Hrvoje Mihanović <i>Long-term (30 years) study of dissolved organic matter in the northern Adriatic sea; an indication of global changes and the bios variations</i>	353
Marko Racar, Mia Gotovuša, Ivan Pucko, Fabio Faraguna <i>Synthesis of fatty acid octyl esters combined with glycerol extraction and reuse of acid catalyst</i>	355
Valentina Gluščić, Mirjana Čačković, Gordana Pehnc, Ivan Bešlić <i>Content of ionic compounds in the ambient fine particulate matter fraction</i>	356
Iva Šimić, Gordana Mendaš, Gordana Pehnc, Andrea Milinković, Sanja Frka <i>Different performances of a bulk collector for the determination of PAHs and PCBs in total deposited matter</i>	357
Materials and nanotechnology	
Irena Ivanišević, Sara Krivačić, Iva Gudan Pavlović, Stjepan Milardović, Petar Kassal <i>Amphiphilic silver nanoparticles for inkjet printed electronics on flexible plastic substrates</i>	358
Iva Rezić, Mislav Majdak, Lela Martinaga, Maja Somogyi Škoc, Vanja Ljoljić Bilić, ž <i>Development and characterization of antibacterial coating with nanoparticles active against MRSA and MSSA</i>	359
Andreja Žužić, Jelena Macan <i>Permanganometric determination of oxygen nonstoichiometry in manganites</i>	360
Jelena Bijelić, Manisha Sahu, Sugato Hajra, Dong Ik Oh, Hoe Joon Kim, Igor Djerdj <i>Triple perovskite-based triboelectric nanogenerator: a facile method of energy harvesting and self-powered information generator</i>	361
Dalibor Tatar, Pascal Cop, Ruben Maile, Yu Sun, Omeir Khalid, Patrick Esch, Sven Heiles, Herbert Over, Bernd M. Smarsly, Igor Djerdj <i>Impact of aliovalent/isovalent ions (Gd, Zr, Pr, and Tb) on the catalytic stability of mesoporous ceria in the HCl oxidation reaction</i>	362
Marija Tkalčević, Jordi Sancho Parramon, Matej Bubaš, Goran Dražić, Peter Nadazdy, Sigrid Bernstorff, Maja Mičetić <i>Magnetron sputtering deposition of 3D networks of nanopores in alumina</i>	363
Mateja Piljić, Maja Somogyi Škoc, Iva Rezić <i>Preparation and characterization of silica-Nigella sativa L. hybrid materials</i>	365
Ivana Periša, Marija Tkalčević, Lovro Basioli, Mile Ivanda, Sigrid Bernstorff, Maja Mičetić <i>Magnetron sputtering deposition of core/shell Ge/Al quantum dot lattices in amorphous Al₂O₃ matrix</i>	366
Marko Robić, Mira Ristić, Stjepko Krehula, Svetozar Musić <i>Synthesis and properties of electrospun fibres in the system Er₂O₃-Fe₂O₃</i>	367
Igor Jajčinović, Sara Pršić, Kristina Tolić, Vedrana Špada, Ivan Brnardić <i>Aging of photocatalysts TiO₂, TiO₂ / multiwall carbon nanotubes and TiO₂ / graphene oxide in air</i>	368

Maria Kolympadi Markovic, Robert Peter, Ivana Jelovica Badovinac, Iva Šarić, Marko Perčić, Rafaela Radičić, Dean Marković, Mato Knez, Gabriela Ambrožić <i>Preparation of ZnO/organosilane/ZnO hybrid thin films via atomic layer deposition (ALD) and solution surface modification.....</i>	389
Marko Dunatov, Andreas Puškarić, Luka Pavić, Lidija Androš Dubraja <i>Structural and dielectric studies of bis(oxalato)chromium(III) complexes with azabicyclic cations</i>	390
Antoneta Tomljenović, Juro Živičnjak, Veronika Stamać <i>Usage durability of knitwear made of man-made artificial fibers from cellulose</i>	391
Juro Živičnjak, Ivan Mihaljević, Zenun Skenderi, Antoneta Tomljenović <i>Comfort of socks made of innovative cellulose materials.....</i>	392
Sanja Perinović Jozić, Ivan Bajan, Miće Jakić, Branka Andričić <i>Preparation of poly(ethylene oxide) film with variation of drying temperature.....</i>	393
Ruža Frkanec, Ilija Brzić, Nikolina Kalčec, Ivana Vinković Vrček, Lucija Horvat, Tihana Kurtović, Leo Frkanec <i>Towards nanobiosensor for coronavirus (Covid-19) detection: conjugation of monoclonal anti-SARS-Cov-2 antibodies to gold nanoparticles.....</i>	394
Berislav Marković, Dalibor Tatar, Aleksandar Miletić, Ákos Kukovecz, Igor Djerdj <i>Synthesis of 1,2-diketones from aldehyde using novel ceria-zirconia high-entropy oxides as actual catalysts</i>	395
Josipa Bilić, Manuel Širola, Vedrana Špada, Neven Peko <i>Analyses on chemical and mechanical stripping of coatings on metal plate mock-ups</i>	396
Kamran Syed, Hrvoje Gebavi, Davor Ristić, Eduard Ilobet, Mile Ivanda <i>Gas Sensors on Flexible Polyimide, Rigid Alumina and Silicon Substrate for the Nitrogen dioxide (NO₂) and Ammonia (NH₃) Gas Detection</i>	398
Sara García-Ballesteros, Josipa Papac, Ana M. Amat, Hrvoje Kušić <i>Environmental aspect of photocatalysis for the degradation of oxytetracycline in water: N-S-TiO₂ vs TiO₂.....</i>	400
WORKSHOPS	
Education	
Vlatka Husetović, Marijana Bastić <i>Vertikalna povezanost kurikulumskih sadržaja kemije i prirode od ishoda na razini aktivnosti preko pokusa do vrednovanja</i>	405
Martina Kalac <i>Radionica aromaterapije u OŠ Maria Martinolića</i>	406
Milan Nikolić, Olgica Martinis <i>Pokusi i ishodi u nastavi kemije</i>	407
Helena Peter Jelenčić, Olgica Martinis <i>Analiza inicijalne provjere znanja iz kemije u srednjoj školi.....</i>	408
Industry and entrepreneurship	
Ernest Meštrović <i>Entrepreneurial skills – workshop</i>	409
Spiridion Brusina Medal Lecture	
Tomislav Friščić <i>Spiridion Brusina Medal Lecture: Solvent-free Notes on Natural Sciences [Predavanje povodom medalje Spiridion Brusina: naravoslovne crtice bez otapala].....</i>	410
INDEX.....	412

COMFORT OF SOCKS MADE OF INNOVATIVE CELLULOSE MATERIALS

Juro Živičnjak,^{a,*} Ivan Mihaljević,^a Zenun Skenderi,^b Antoneta Tomljenović^a

^a Department of Materials, Fibers and Textile Testing, University of Zagreb Faculty of Textile Technology, Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

^b Department of Textile Design and Management, University of Zagreb Faculty of Textile Technology, Prilaz baruna Filipovića 28a, 10000 Zagreb, Croatia

* juro.zivicnjak@ttf.unizg.hr

The socks are knitted next-to-skin-type garments worn on the feet and often covering the ankle and some part of the calf. They have to fulfill high demands of functionality, comfort, durability and design. As the comfort of socks depends on their construction and materials used, it is very important to select fibers and yarns for their production. The number of European standards related to testing of knitwear and socks are low.^[1] With increasing demand for garment comfort, there are many studies related to the comfort properties of fabrics. However, there are significantly less studies examining the thermal comfort of socks, which are using thermal foot model.^[2]

The socks are usually made from cotton yarns for softness and comfort and blended with polyamide or Lycra for improved fit, durability and shrink resistance. Therefore, and with the fact that the applicability of modal fibers and microfibers (man-made artificial fibers from cellulose which provide silky touch and exceptional contact comfort) in knitting of socks is insufficiently researched, as well as yarns made from them by unconventional rotor and air-jet process, in this paper properties of two groups of socks, made of innovative materials – single ring, rotor and air-jet spun yarns of the same linear density (all made of bright staple modal fibers of linear density of 1.3 dtex and modal microfibers of 1.0 dtex respectively) in full plating by textured polyamide 6.6 yarns of different linear density were evaluated. Evaluation of sock comfort was carried out by investigation of water vapor absorption and air permeability of socks knitted fabrics and socks thermal comfort before and after five repeated washing and drying cycles by measuring of thermal resistance on the thermal foot.

Acknowledgments. This paper is funding by the Croatian science foundation within the Project IP-2016-06-5278.

REFERENCES

[1] A. Tomljenović, et al., *Fibers & Textiles in Eastern Europe* **2016**, *24*, 129-138.

[2] Z. Skenderi, et al., *Leather & Footwear* **2017**, *66*, 12-21.

Introduction

The socks are knitted next-to-skin-type garments worn on the feet and often covering the ankle and some part of the calf. They have to fulfill high demands of functionality, comfort, durability and design. As the comfort of socks depends on their construction and materials used, it is very important to select fibers and yarns for their production.



Figure 1. Male socks: a) in calf length, b) in over calf length

The socks are usually made from cotton yarns for softness and comfort and blended with polyamide or Lycra for improved fit, durability and shrink resistance. Recently innovative cellulose materials like modal fibers and microfibers (man-made artificial fibers from cellulose) which provide silky touch and exceptional contact comfort are used in knitting of socks, as well as yarns made by unconventional rotor and air-jet process.

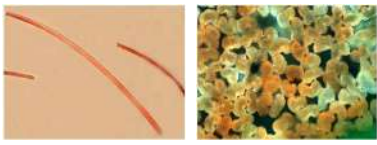


Figure 2. Microscopic images of longitudinal view and cross section of modal fibres



Figure 3. Structure of ring, rotor and air-jet spun yarns

Materials

With the fact that the applicability of modal fibers and microfibers in knitting of socks is insufficiently researched, as well as yarns made from them by unconventional rotor and air-jet process, in this paper properties of two groups of socks (A and B), made of innovative materials – single ring (P), rotor (R) and air-jet (A) spun yarns of the same linear density (all made of bright staple modal fibers (MD) of linear density of 1.3 dtex and modal microfibers (MMD) of 1.0 dtex respectively) in full plating by textured polyamide 6.6 yarns of different linear density were evaluated.

The socks were made using Lonati automatic sock-knitting machine with E9 gauge of cylinder diameter 95 mm (3 3/4") with 108 needles and then ironed at a temperature of 120 °C using Cortese machine.

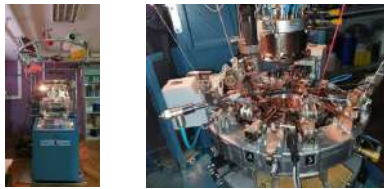


Figure 4. Lonati, Goal FL 626 automatic sock-knitting machine

The investigation was carried out on two groups of calf length male socks of the same size (EU 42). Plain knit stitch was used in the foot and leg area, and rib stitch was used at the top of the socks. Textured polyamide multifilament yarn was knitted into toe, heel, foot and leg areas of socks for reinforcement and support along with the three soft single spun yarns made of modal or micromodal fibers. Single Lycra of higher linear density (54 tex) was knitted into the ribbing at the top of the all socks to prevent their falling down. Characteristics of male socks produced are shown in Table 1, including values of fiber content and yarn characteristics used for knitting.

Table 1. Characteristics of two groups of calf length male socks

Sock group	Sock content	Fiber content [%]		Yarn characteristics	
		plain	rib	plain	rib
A	MD or MMD	79	55	P, R or A of 20 tex	P, R or A of 20 tex
	PA 6.6	21	34	156 dtex f 42	156 dtex f 42
	Lycra	/	31	/	54 tex f1
B	MD or MMD	71	52	P, R or A of 20 tex	P, R or A of 20 tex
	PA 6.6	29	19	220 dtex f 68	220 dtex f 68
	Lycra	/	29	/	54 tex f1

Description: P - ring, R - rotor and A - air-jet spun yarns

Methods

The number of European standards related to testing of knitwear and socks are low. With increasing demand for garment comfort, there are many studies related to the comfort properties of fabrics. However, there are significantly less studies examining the thermal comfort of socks, which are using thermal foot model. Therefore, evaluation of sock comfort was carried out by investigation of water vapor absorption and air permeability of knitted fabrics of socks and socks thermal comfort before and after five repeated washing and drying cycles by measuring of thermal resistance on the thermal foot. Washing were performed according to the procedure 3M at 30°C (mild agitation during heating, washing and rinsing) with non-phosphate ECE reference detergent (without optical brightener) and drying by open-air drying (procedure A, line dry) of EN ISO 6330. Before testing all socks were conditioned at temperature: 20 ± 2°C and air relative humidity: 65 ± 4%.



Figure 5. Preparation of sock for water vapor absorption and air permeability test

Water vapor absorption is determined according to the ASTM D 2654-89a. Plain knit circular samples of 100 cm² were cut from conditioned body of the sock and weighted (m_c), then dried in an oven at 105 ± 2°C for 24 h and reweighted (m_{as}). The difference between the mass of conditioned and the mass of oven-dried samples is calculated as moisture regain in percentage according to the Formula 1:

$$M_r = \frac{m_c - m_{as}}{m_{as}} \cdot 100 \quad (1)$$

M_r – moisture regain [%],
 m_c – mass of the conditioned sample [g] and
 m_{as} – mass of the absolute dry sample [g].

Permeability of fabrics to air is determined according to the EN ISO 9237 using test surface area of 5 cm² and pressure drop of 100 Pa. Arithmetic mean of the 10 individual readings were calculated according to the Formula 2:

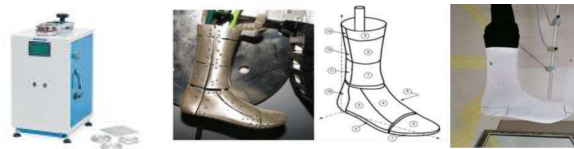
$$R = \frac{qv}{A} \cdot 167 \quad (2)$$

qv – arithmetic mean of air flow [dm³/min],
 A – test surface area [cm²] and
 167 – conversion factor from dm³/min cm² in mm/s.

Thermal resistance can be defined as the ability of the material to resist the heat flow through the its structure. Thermo-physiological sock properties were determined by measuring thermal resistance on a Thermal Sweating Foot Manikin System, size 42, which has 13 independent heating (35 ± 0.5°C) and measuring segments. The thermal resistance of the tested sock sample R_{ct} is obtained from the difference R_{ctu} and R_{cto} according to the Formula 3:

$$R_{ct} = R_{ctu} - R_{cto} \quad (3)$$

R_{ct} – thermal resistance of the tested sock [m² °C W⁻¹],
 R_{ctu} – total thermal resistance of apparatus and sock [m² °C W⁻¹] and
 R_{cto} – thermal resistance of apparatus (Thermal Foot) [m² °C W⁻¹].



a) Air permeability Tester

b) Thermal Sweating Foot Manikin

Results and discussion

By evaluating the comfort of socks - testing the ability to absorb moisture, air permeability and thermal resistance of socks (measured directly on the thermal foot by determining the resistance to heat transfer) before and after five washing and drying cycles of simulated home care, it was found that the amount of absorbed moisture depends primarily on the socks fiber content, air permeability on knits compactness and porosity, and socks heat transfer (thermal resistance) on the linear density of fibers used for production of spun yarns and structure and porosity of knits.

Table 2. Moisture regain before and after five washing and drying cycles

Sock sample	M_{r0} [%]	M_{r5} [%]	ΔM_r [%]
MD-P-A	9.29	9.93	6.91
MD-P-B	8.19	9.37	14.43
MD-R-A	9.42	9.76	3.58
MD-R-B	8.29	9.34	12.62
MD-A-A	9.13	9.26	1.36
MD-A-B	8.19	9.69	18.36
MMD-P-A	9.63	9.65	0.19
MMD-P-B	8.39	9.79	16.77
MMD-R-A	9.30	9.75	4.89
MMD-R-B	8.37	9.12	8.93
MMD-A-A	9.26	9.69	4.66
MMD-A-B	8.38	9.09	8.49

Description: M_{r0} - moisture regain before five washing and drying cycles; M_{r5} - moisture regain after five washing and drying cycles; ΔM_r - percentage difference between the M_{r0} and M_{r5}

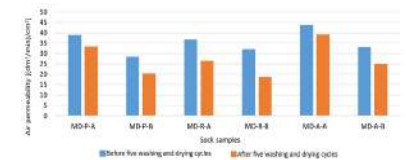


Figure 7. Air permeability of socks from modal fibers

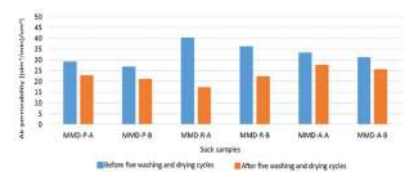


Figure 7.1. Air permeability of socks from micromodal fibers

Table 3. Thermal resistance of socks before and after five repeated washing and drying cycles

Sock sample	R_{ctu} [m ² ·°C/W]		R_{cto} [m ² ·°C/W]		$(R_{ctu} / R_{cto}) \times 100$ [%]	
	Non-washed	5x washed	Non-washed	5x washed	Non-washed	5x washed
MD-P-A	0.15914	0.14074	0.01178	0.00178	7.41	1.27
MD-P-B	0.15674	0.14633	0.01684	0.00737	10.75	5.04
MD-R-A	0.15663	0.14627	0.01673	0.00731	10.68	5.00
MD-R-B	0.16176	0.14829	0.01440	0.00933	8.90	6.29
MD-A-A	0.16051	0.15107	0.01315	0.00765	8.20	5.07
MD-A-B	0.15728	0.15055	0.01317	0.00713	8.38	4.74
MMD-P-A	0.15083	0.14166	0.02558	0.01778	16.96	12.55
MMD-P-B	0.15635	0.14576	0.03110	0.02188	19.89	15.01
MMD-R-A	0.15777	0.14403	0.03251	0.02015	20.61	13.99
MMD-R-B	0.15497	0.14521	0.02971	0.02134	19.17	14.70
MMD-A-A	0.15293	0.14410	0.02768	0.02022	18.10	14.03
MMD-A-B	0.15272	0.14716	0.02587	0.02328	16.94	15.82

Description: R_{ctu} - total thermal resistance of apparatus and sock; R_{cto} - thermal resistance of the tested sock

Conclusion

After the simulation of care in all tested socks, changes in the values of the tested properties were determined, which justifies the application of the proposed methodology in evaluating their comfort and usability. The applicability of the innovative materials used for the production of socks has been confirmed.

ACKNOWLEDGMENT

This paper is funding by the Croatian science foundation within the Project IP-2016-06-5278 (Comfort and antimicrobial properties of textiles and footwear, principal investigator: Prof. Zenun Skenderi, PhD).