Antimicrobial Surface Functionalisation of Polylactide Fibres

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Introduction

Polymeric antibacterial agent

- Poly(dimethylaminoethyl methacrylate) has a known antimicrobial properties against bacteria, fungi, moulds etc, in its tertiary form!
- In linear form this polymer is soluble in many solvents, including water,
- Crosslinking and complexation can offer unsolubility
- Typical use – gen transfer procedures
- Different methods of polymerisation can be use
- It is a polyelectrolyte

Introduction

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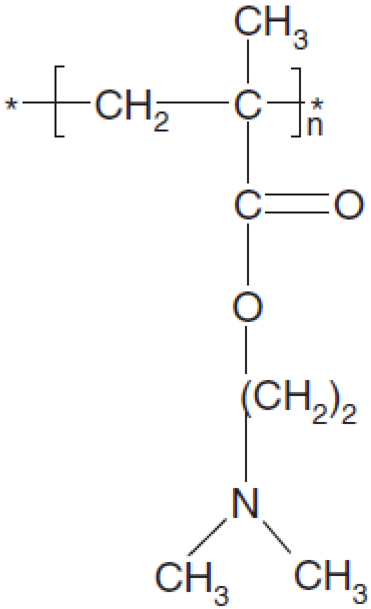
Modification procedure

- Object: PLA fibers with a linear density of 6.7 dtex and a length of 60mm
- Modifier: PDMAEMA was prepared by radical polymerization of dimethylaminoethyl methacrylate (DMAEMA) initiated with azobisisobutyronitrile



Modification procedure

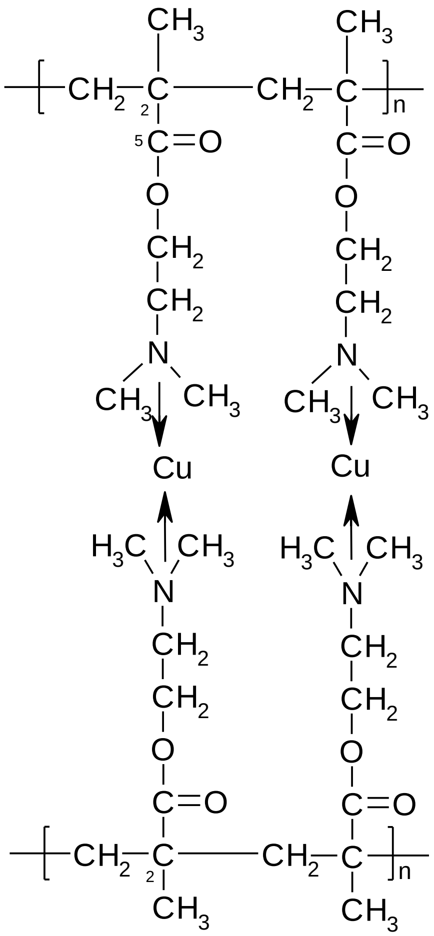
Possible methods of depostion PDMAEMA

- PLA fiber + padding of PDMAEMA in different amounts → nonwoven production
- PLA fiber + padding of PDMAEMA in different amounts → nonwoven production + complexation with copper → unsoluble modifier
- PLA fiber + padding of PDMAEMA in different amounts → nonwoven production + complexation with silver → unsoluble modifier
- PLA nonwoven + PDMAEMA spaying + complexation with copper → unsoluble modifier

Modification procedure

Composition	Deposition (%)
PLA	-
PLA+PDMAEMA	1,1
PLA+PDMAEMA	2,7
PLA+PDMAEMA	5,1
PLA+PDMAEMA+Ag	2,7+6,0
PLA+PDMAEMA+Cu	2,7+3,8
PLA+PDMAEMA+Cu	5,1+21,9

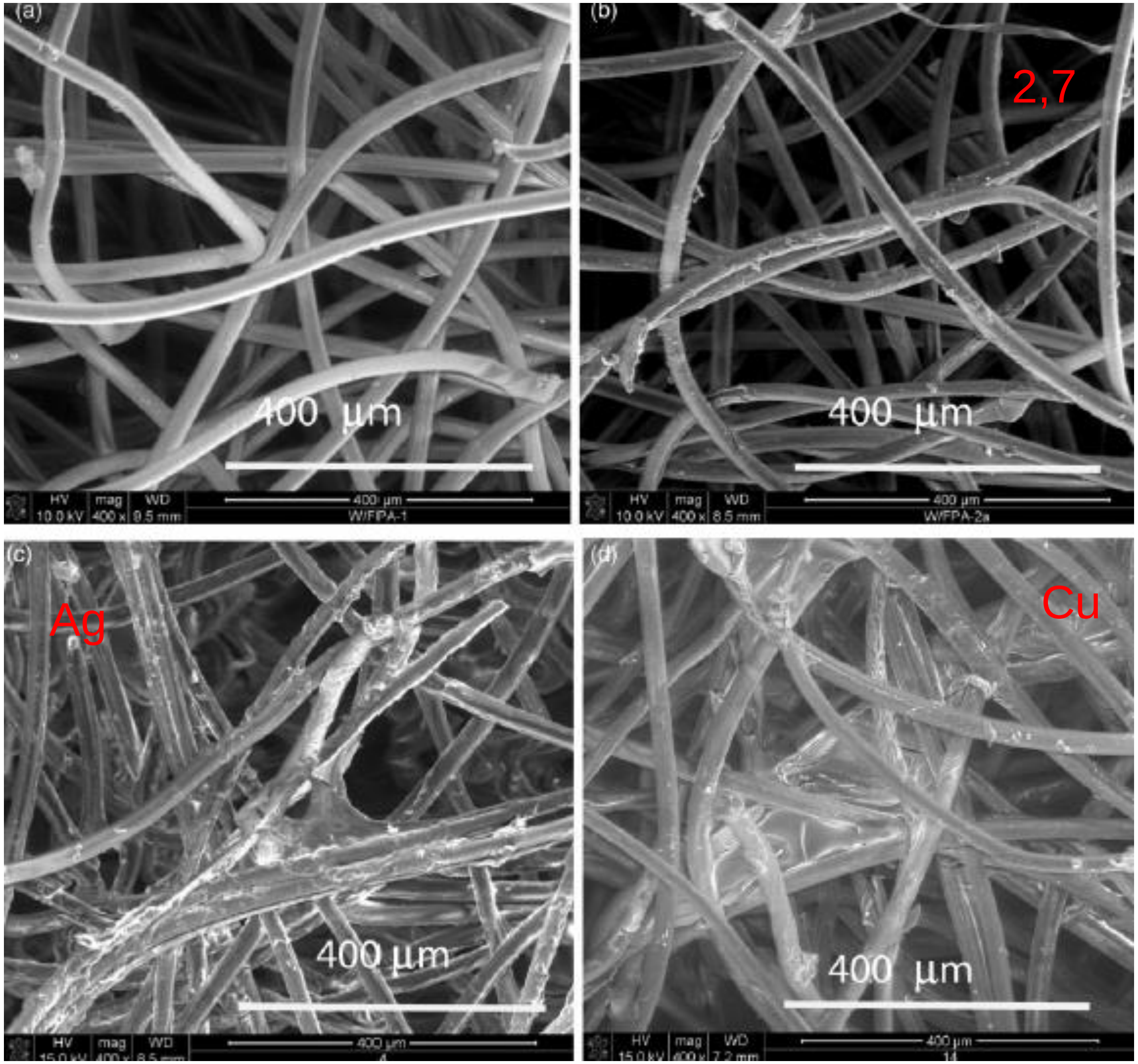
Modification effects



Modification effects

	Percentage share of the elements on the surface [%]					
sample	C	O	N	Ag	S	Cu
PLA	49.7	50.3	not observed	not observed	not observed	not observed
PLA+PDMAEMA	46.4	53.6	not observed	not observed	not observed	not observed
PLA+PDMAEMA	46.3	45.7	8.0	not observed	not observed	not observed
PLA+PDMAEMA	40.2	46.0	13.8	not observed	not observed	not observed
PLA+PDMAEMA+Ag	46.2	47.5	not observed	6.3	not observed	not observed
PLA+PDMAEMA+Cu	39.9	42.5	not observed	not observed	3.6	14.0
PLA+PDMAEMA+Cu	40.9	38.5	not observed	not observed	3.9	16.7

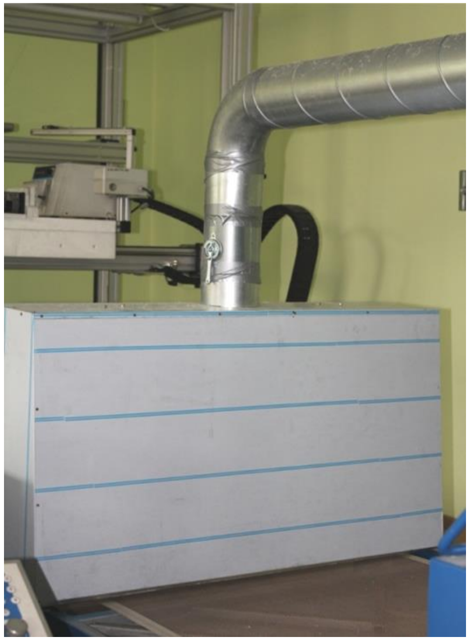
Modification effects



Modification effects

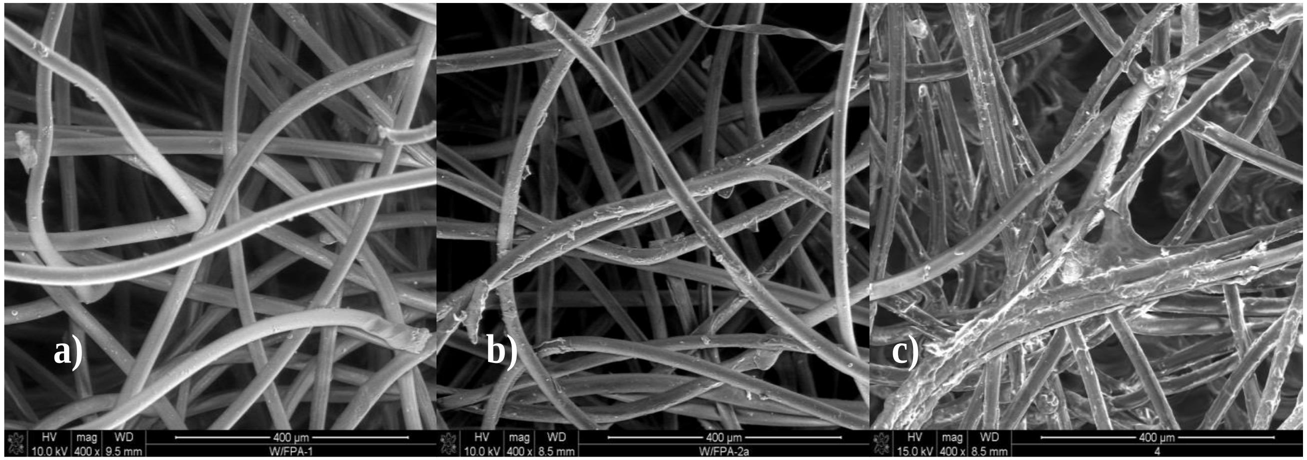
Nonvowens/ (time of incubation)	Reduction (%)										
	E.coli	S.aureus	S.haemolyticus	B.subtilis	B.subtilis	C.albicans	C.parapsilosis	A.niger	A.fumigatus	A.versicolor	P.crustosum
PLA (t=8h)	0	0	88	0	0	0	0	78	0	68	40
PLA+ PDMAEMA 1.1% (t=8h)	40	33	82	0	100	95	99	93	0	71	44
PLA+ PDMAEMA 2.7% (t=8h)	82	55	99	54	99	100	100	97	82	51	67
PLA+ PDMAEMA 5.1% (t=8h)	100	100	100	100	100	100	100	61	45	93	72
PLA+ PDMAEMA 2.7% +Ag 6% (t=8h)	99	98	48	100	100	87	66	100	100	100	71
PLA+ PDMAEMA 2.7%+Cu 3.8% (t=8h)	100	100	100	100	100	100	100	99	84	72	67
PLA+ PDMAEMA 5.1% +Cu 21.9% (t=8h)	99	100	82	100	100	100	100	56	83	88	74

Modification by spraying



Modification by spraying

	Sample weight [g]	Weight after first spaying* [g]	Amount of modifier [g]	Percentage of modifier [%]	Weight after second spraying** [g]	Amount of modifier II [g]	Percentage of modifier II [%]
PDMAEMA	30,8	31,4	0,6	1,95	-	-	-
Commercial biocid	31,9	32,3	0,4	1,25	-	-	-
PDMAEMA-Ag	30,5	31,2	0,7	2,30	31,6	0,4	1,31
PDMAEMA-Cu	31,2	31,9	0,7	2,24	32,6	0,7	2,24



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GOOD PRACTICE EXAMPLES

Good practice examples

- Modifier is strongly connected with fiber surface - leaching into the environment is impossible
- PDMAEMA can be deposited from water solution
- it has excellent antimicrobial efficiency against wide range of germs: bacteria, fungi, moulds, etc.;
- Modifier is not a nanoparticle
- PDMAEMA can be use for modification of biodegradable polylactide fibres

Nanotechnology risks

(i) nanoparticles because of its size can behave unpredictably;
(ii) it can go throw the physiological barriers into the human cells or brain,
(iii) probably it can damage defensive mechanisms of living organisms,
(iv) nanoparticels are so strongly chemically active that can damage biological systems,
(v) it can create special problems during production, storing, use, recycling, etc.

Detailed description

Papers:

Beata Gutarowska, Dawid Stawski, Justyna Skóra, Lucyna Herczyńska, Katarzyna Pielech-Przybylska, Stefan Połowiński, Izabella Krucińska: PLA nonwovens modified with poly(dimethylaminoethyl methacrylate) as antimicrobial filter materials for workplaces – Textile Research Journal 85 (10), 1083-1094 (2015)

Stefan Połowiński, Roman Jantas, Joanna Szumilewicz, Dawid Stawski, Lucyna Herczyńska, Zbigniew Draczyński: Modification of PLA Fibres with Bioacceptable Hydrophilic Polymers – Fibres & Textiles in Eastern Europe 20, 78-85 (2012)

Roman Jantas, Stefan Połowiński, Dawid Stawski, Joanna Szumilewicz: Modification of a Polylactide Fibre Surface – Fibres & Textiles in Eastern Europe 18, 87-91 (2010)

Patents:

Method for preparing composite material, involves applying aqueous solution of poly (2-(N, N-dimethylamino) ethyl methacrylate) as top layer on non-woven microfibers followed by applying successive layers of antimicrobial to silver layer, Polish patent

Acknowlegments

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Thank you!

Questions welcome

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