

13:00-14:00 Präsentation der Ergebnisse aus dem Projekt „MAKOFILT“

- Präsentation der neuen Ergebnisse
- Diskussion

14:00-15:15 Imbiss und Austausch zwischen den PA-Mitgliedern

Ende der Veranstaltung

02.07.2024

3. PA-Sitzung, Krefeld

IGF-Projekt „Maßgeschneiderte konstruktive und chemische Optimierung von Drainage- und Koaleszenzfiltermedien zur Verbesserung der Energiebilanz der Druckluftfiltration (MAKOFILT)“

Projekt-Nr. 22356 N

(Laufzeit: 01.07.2022 - 31.12.2024)

L. Tsarkova und M. Wittmar

DTNW, Krefeld

IUTA e.V., Duisburg

MAKOFILT: Arbeitsdiagramm



Arbeitsschritte	Zeitraum (Projektmonat)																								Mon											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24												
1. Erweiterung Prüfstand	IUTA																								6											
2. Zentrifugation	DTNW																								6											
3. Auswahl Medien			DTNW																									12								
4. Beschichtungsverfahren				DTNW																											15					
5. Probenherstellung				DTNW																															19	
6. Messung der Filtrationseigenschaften				IUTA																																19
7. Erarbeitung Auslegungsrichtlinie																					DTNW				5											

Laufzeit: 01.07.2022 - 31.12.2024 (30 Monate)

4.PA Sitzung am 5.12.2024 (Do) ab 12:00 Uhr (IUTA, Duisburg)

- Aktueller Stand des "Universal PFAS Restriction Proposal"
- Neues aus Forschung & Entwicklung
- Erläuterung zur Medienauswahl durch Zentrifugationsversuche
- Ergebnisse zum Ansatz "Konstruktive Optimierung"

Konstruktionen aus dünnen thermoplastischen Drainage- und Koaleszenzmedien

Konstrukte aus Metallgewebe und Koaleszenzmedien

- Einfluss des Öltyps (Viskosität) auf die Abscheideleistung
- Ansatz zum chemischen Maßschneiden der Medien

Aktueller Stand - Universal PFAS restriction proposal



1. Latest updates
 - [Highlights from June RAC and SEAC meetings - upcoming sectors announced](#), 13 June
 - [Dossier Submitter's ongoing role in the PFAS restriction proposal](#) - news from German BAuA, 15 April 2024
 - [Next steps for PFAS restriction proposal](#), 13 March 2024
 - [Highlights from November RAC and SEAC meetings](#), 7 Dec 2023
 - [Enforcement Forum's advice on enforceability of the proposed PFAS restriction](#), 8 Nov 2023
 - [All comments submitted to the PFAS restriction proposal now online](#), 2 Nov 2023
 - In der sechsmonatigen öffentlichen Konsultation war eine bisher unübertroffene Anzahl an Kommentaren (**5642, mehr als 100 000 Seiten**) eingegangen.
 - Die Kommentare enthalten neben umfangreichen Informationen zu den Verwendungen von PFAS in der EU und dem Europäischen Wirtschaftsraum (EWR) auch Informationen zur **Eignung von Alternativen und zu den sozio-ökonomischen Auswirkungen der vorgeschlagenen Beschränkung**
-

Aktueller Stand - Universal PFAS restriction proposal



KEY REGULATORY DATES IN THE EU



In den nächsten drei Ausschusssitzungen von RAC und SEAC werden folgende Themen und Sektoren adressiert:

Sitzungen im März 2024:

- Verbrauchergemische, Kosmetika und Skiwachs
- Gefahreigenschaften der PFAS (nur im RAC)
- Allgemeine Vorgehensweise (nur im SEAC)

Sitzungen im Juni 2024:

- Metallbeschichtung und Herstellung von Metallprodukten
- Zusätzliche Diskussion über die Gefahreigenschaften (nur im RAC)

Sitzungen im September 2024:

- Textilien, Polstermöbel, Leder, Bekleidung, Teppiche (TULAC)
- Lebensmittelkontaktmaterialien und Verpackungen
- Erdöl und Bergbau

Informationen zum weiteren Zeitplan und zu den geplanten Diskussionen in den Ausschüssen werden seitens der ECHA nach und nach bekannt gegeben. Die Veröffentlichung ist immer parallel zu den Ausschusssitzungen geplant.

Aktueller Stand - Universal PFAS restriction proposal



Annex E to the ANNEX XV RESTRICTION REPORT - Per- and polyfluoroalkyl substances (PFASs)

Use of C6 side-chain fluorinated polymers in filtration and separation media

The restriction proposal for PFHxA includes a derogation for filtration and separation media used in high performance air and liquid applications that require a combination of water- and oil-repellence.

SEAC concluded in its opinion that: During the consultation on the Annex XV report, several stakeholders requested a complete derogation for the use of PFHxA in filters and membranes.

The Dossier Submitter proposes a derogation for filtration and separation media used in high performance air and liquid applications that require a combination of water- and oil repellence properties, even though it is well-noted in the Background Document and by SEAC that such a broad derogation leads to a certain degree of uncertainty as it might be possible that alternatives are already available or will become so in near future for some applications.

Cost estimates for the uses affected are scarce, only some information was provided by stakeholders during the consultations. **This information mainly indicates that specifically costs related to substitution, e.g. loss of effectiveness of products due to no alternatives being available currently, could be potentially very high.** Stakeholders reported that appropriate filtration reduces maintenance needs, extends service life and prevents failures of equipment; they also expect energy consumption and related greenhouse gas emissions to increase in the absence of C6-treated filtration media. During the consultations on the Annex XV report and the SEAC draft opinion, it was stated that the absence of a derogation will put manufacturing facilities located in the EU at risk and result in a supply interruption of filtration and separation media for several purposes until adequate alternative candidates are identified and requalified.

SEAC agrees to the Dossier Submitter's conclusion that more information on the different applications and specifically a more detailed discussion on substitution possibilities as well as on any potential related costs would be needed in order to draw a robust conclusion on the socio-economic impacts. The Dossier Submitter has not received any information that affects this conclusion.

Annex E to the ANNEX XV RESTRICTION REPORT - Per- and polyfluoroalkyl substances (PFASs)

- ❖ Similarly, one stakeholder providing information in relation oil- and water-repellent PFASbased finishes in industrial filter applications such as **coalescing filters** highlights that **no alternative is known that is able to provide both water and oil repellence**. With respect to PTFE-based membranes for filtration of very fine particles with **high chemical and temperature resistance**, the same stakeholder notes that the chemical **and temperature resistance of potential alternatives is insufficient**. A producer of filtration products for application in a wide variety of industries furthermore notes that **PTFE's unique performance properties cannot be matched by any known non-PFAS alternative**. ..While such filter media can also be produced without the use of PFASs, these alternatives **still need to be trialled, tested and validated by downstream users – with doubts** being expressed that these alternatives would work in all applications.

With respect to high performance membranes, some individual submissions to the 2nd stakeholder consultation specifically state that **alternatives are not available for coalescing filter** as well as PTFE-based membranes for the filtration of very fine particles. Another stakeholder reports that some suppliers provide alternatives to PTFE membranes and PFAScoated products, but that these suppliers use PFASs during the production process. While production without PFASs seems possible, **such alternatives still need to be trialled and validated**.

- ❖ **Proposed derogation:** Textiles for the use in filtration and separation media used in high performance air and liquid applications in industrial or professional settings that require a combination of water- and oil repellence

The timeframe of 18 to 36 months for tests and approval along the supply chain reported for medical textiles is also reported to be relevant for filtration applications.

A stakeholder providing information based on its **past experience with substitution from C8 to C6 substances in filtration applications reports that substitution took eight to ten years**. A supplier of filters for mist and dust removal in a variety of industrial applications submitting information to the 2nd stakeholder consultation reports a shorter timeframe of at **least three years for commercializing the alternative technology** and receiving customer validation and approval. *Substitution might thus be feasible in the timeframe available until the restriction takes full effect but some uncertainty prevails – especially based on practical experiences from the past.*

Table 1 | Summary of PFAS-Free Alternative Chemistries and Materials

PFAS Alternative Chemistry	Function	Potential Hazards
Silicones/siloxanes		While Polydimethylsiloxane (PDMS or dimethicone) is generally considered inert and without adverse effects, it can contain cyclic siloxane impurities known as D4 and D5 that are persistent and bioaccumulative.
Silanes		Some silanes used to treat textiles such as chlorotrimethylsilane are persistent, mobile, and toxic. Dimethoxydimethylsilane is a reproductive and chronic toxicant.
Paraffin waxes/hydrocarbons		Aquatic chronic toxicity of C9-C14 Isoparaffins.
Fatty acid derivatives		Relatively low hazard materials.
Melamine and melamine formaldehyde coatings		Melamine is listed as an International Agency for Research on Cancer (IARC) group 2B carcinogen (potentially carcinogenic to humans) and may cause damage to the kidney and bladder. Formaldehyde is on the US Department of Toxic Substances Control's (DTSC) Candidate Chemical List, citing carcinogenicity, hepatotoxicity, digestive system toxicity, ocular toxicity, and respiratory toxicity.
Polyurethane coatings		Hazards are mostly associated with monomers used in the manufacture of polyurethanes. Polymer forms such as polyurethane emulsions present lower risk.
Acrylates/Acrylic Polymers		Hazards are mostly associated with monomers used in the manufacture of acrylic polymers. Polymer forms such as acrylic polymer emulsions present lower risk.
Dendrimers		Hazard traits are based on individual components of specific dendrimer formulations (e.g., organic silicon compound, organic acid, acetic acid, functionalised polymer, cationic surfactant, hydrophilic group, crosslinker).
Silicon dioxide nanoparticles		Potential neurotoxicity and genotoxicity.
Titanium dioxide (TiO ₂) nanoparticles		TiO ₂ (airborne, unbound particles of respirable size) is on DTSC's Candidate Chemical List because it is on the Prop 65 list as a carcinogen and on the International Agency for Research on Cancer (IARC) Carcinogen list 2B (possible carcinogenic to humans). TiO ₂ is also persistent and can release metal ions into the environment.

Water repellency
 Soil repellency
 Stain repellency
 Oil repellency

Note: Potential Hazards listed are taken from the DTSC's potential alternatives to perfluoroalkyl and polyfluoroalkyl substances (PFAS) in treatments for converted textiles or leathers. [DTSC](#)

GLOBAL LEADING CONSULTANTS

NIRI Report: Tackling the Issues of Per- and Polyfluoroalkyl Substances (PFAS) Replacement in the Nonwoven Industry (OKT. 2023)

www/nonwovens-innovation.com

- ❖ Strategien zur Umgestaltung von Produkten, um ihren Bedarf an PFAS zu verringern
- ❖ Ansätze, um die Leistung und Wirksamkeit von Produkten ohne PFAS zu erreichen
- ❖ Beschaffung von PFAS-freien Alternativprodukten und -komponenten
- ❖ Entwicklung und Prototyping von PFAS-freien Produkten
- ❖ Die Synthese von PFAS-freien Beschichtungen und abweisenden Behandlungen
- ❖ Die Behandlung von Fasern und Vliesstoffen mit PFAS-freien Chemikalien
- ❖ Prüfung und Validierung der Produktleistung
- ❖ Unterstützung bei der kommerziellen Umsetzung von PFAS-freien Ansätzen

Figure 4 | Demonstration of OrganoClick AB's Dendrimer Oragnotex technology

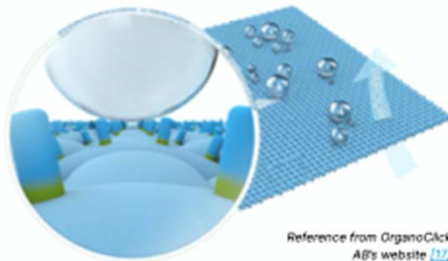
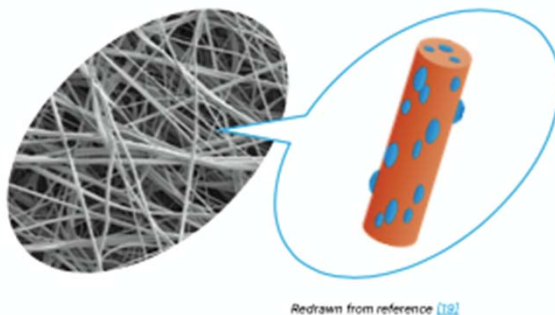


Figure 5 | An illustration of fibres generated in-situ with nanoscale features, for example by electrospinning

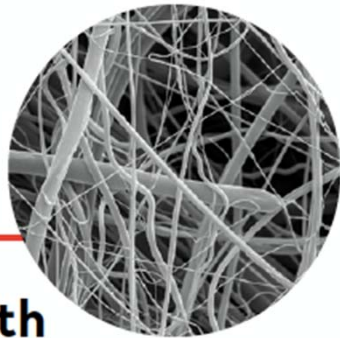


GLOBAL LEADING CONSULTANTS

NIRI Report: Tackling the Issues of Per- and Polyfluoroalkyl Substances (PFAS) Replacement in the Nonwoven Industry (OKT. 2023)

www/nonwovens-innovation.com

There is no one route to PFAS replacement, but by fundamentally reappraising the design of existing nonwoven products that currently rely on PFAS additives, and by harnessing PFAS-free functional coatings coupled with intelligent nonwoven fabric design, it is often possible to meet key performance requirements using an entirely PFAS-free approach



P. Glatzeder

Filtration with Nanomelt technology

The producer of technical textiles and nonwovens, P. Glatzeder GmbH, Detmold/Germany, announced a breakthrough in the production of meltblown nonwovens made of polypropylene (PP) with a focus on nanofibers. The company has ongoing research into manufacturing filtration materials. A key aspect of these efforts is the development and perfection of the Nanomelt technology, a process that makes it possible to produce meltblown nonwovens with nanofibers averaging 600 nm in thickness. This is a significant advance in filtration technology, as it enables more efficient filtration compared to conventional meltblown fibers.

The range includes both standard PP meltblown with a basis weight of 17–150 g/m² and nanofiber PP meltblown with a basis weight of 17–50 g/m². Meltblown nonwovens are widely used in various filtration applications, including air and liquid filtration. The most important applications include respiratory protection, water filtration, fuel filters, vacuum cleaner bags, and cabin filters.



Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa



Reduction in oil mist filtration resistance using novel fibrous filters with bioinspired fibrous membrane

Yufeng Liu, Jinjie Lu, Zhongli Ji^{*}, Cai Linghu, Lang Liu, Cheng Chang, Zhen Liu

Beijing Key Laboratory of Process Fluid Filtration and Separation, College of Mechanical and Transportation Engineering, China University of Petroleum, Beijing 102249, China

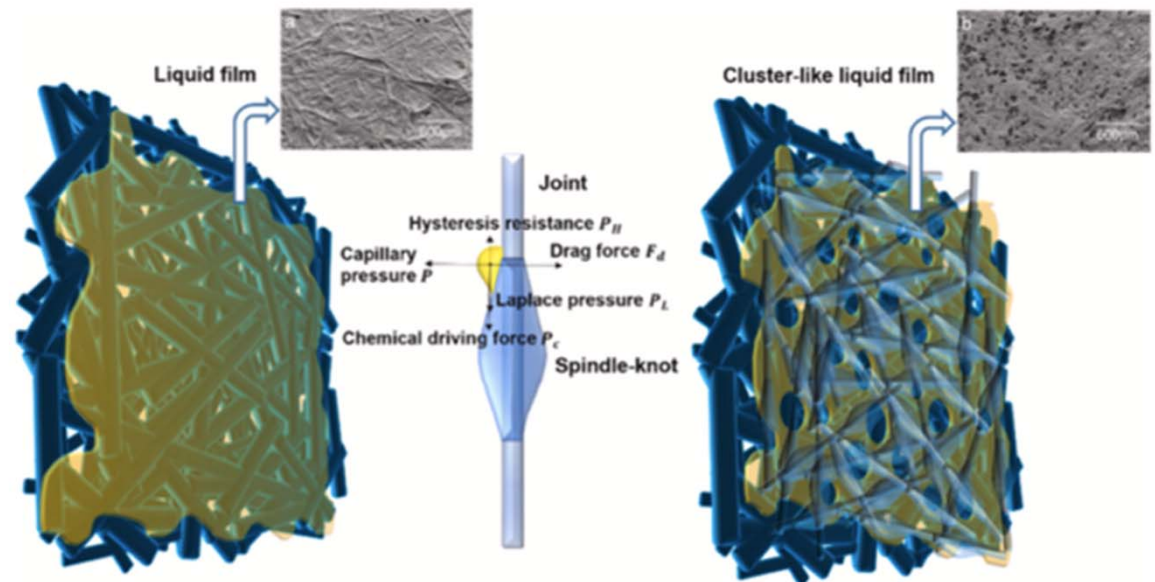
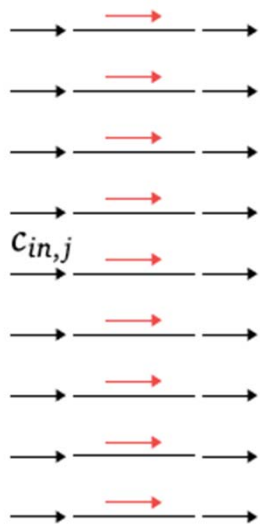


Fig. 8. Illustration schematic of the liquid film morphology.

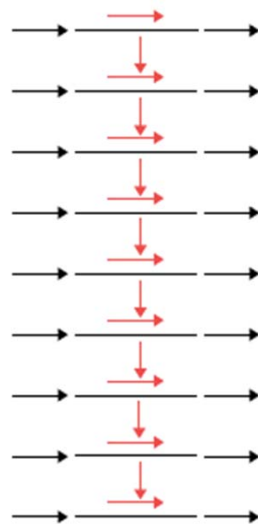
Zentrifugationsversuche

Journal of Aerosol Science 169 (2023) 106129

(b) $S_M \gg 1$

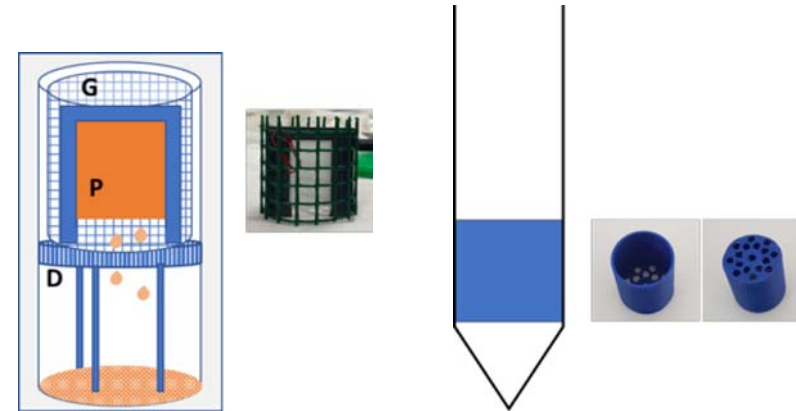


$S_M \approx 1$



a new dimensionless number S_M is defined as the ratio between pressure and gravitational forces, that is

$$S_M = \text{pressure gradient} / \text{gravitational}$$



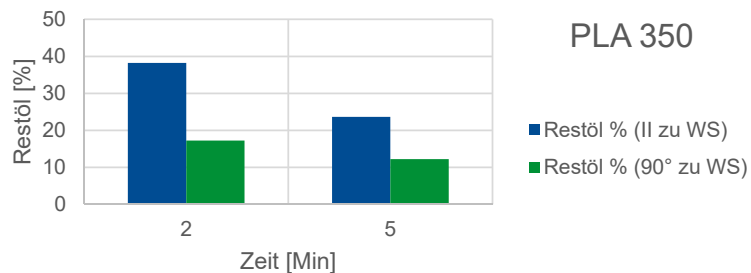
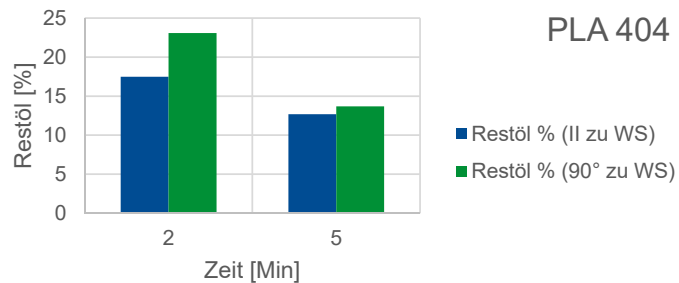
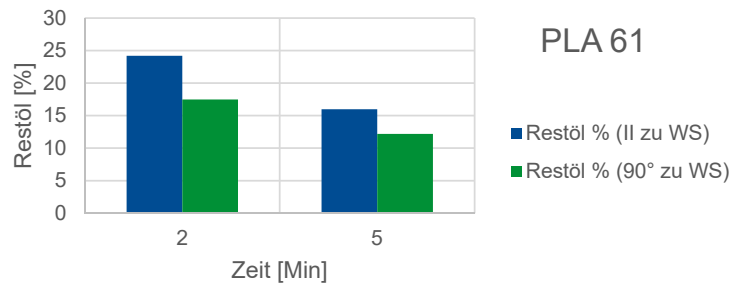
Links: Großraumbehälter, nur Eppendorf mit G Gitterkäfig, P Probenhalter mit ölabetzter Probe – siehe Foto, D Distanzhalter zum Olabscheideraum.
Rechts: IUTA-Konfiguration, Einsatz für 25 ml Röhrchen, Innendurchmesser 20 mm.

Glasfaser Variante G (oleophil/oleophob)

40mm Stanzling:	Restöl
2' 720 rpm Anstr. unten	94%
2' 720 rpm Abstr. unten	98%
2' 1000 rpm Anstr. unten	90%
2' 720 rpm senkrecht	64%

Zentrifugationsversuche

➤ Einfluss der Ausrichtung der Fasern / Corena Öl bei 720 rpm

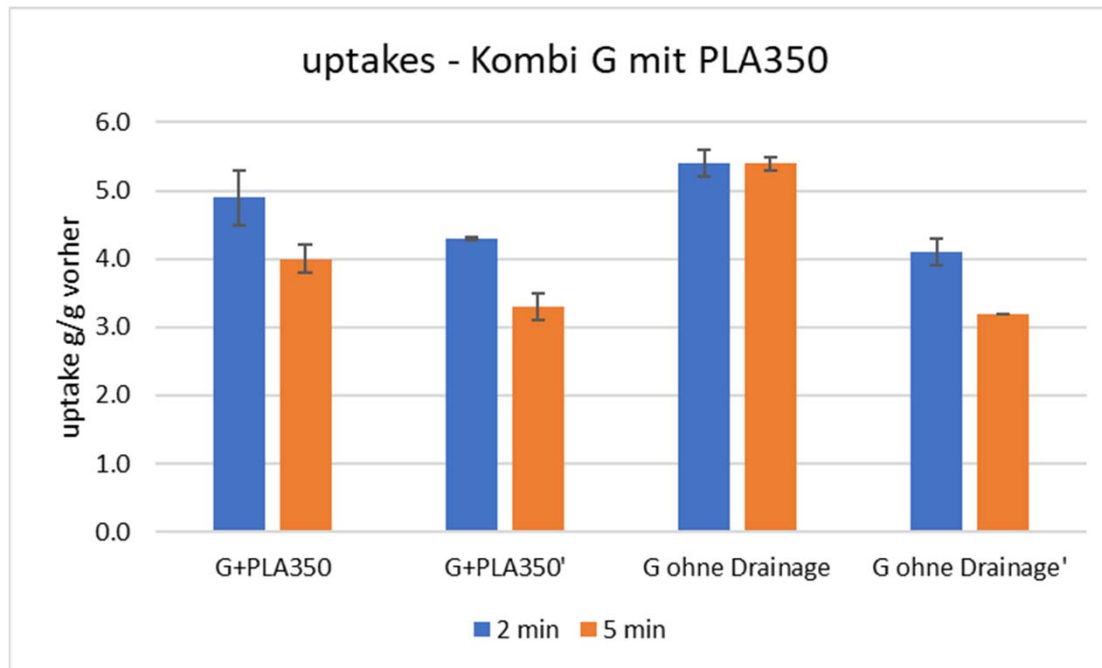


Spinnvliesstoffe aus PLA (STFI) REM 100x	Charakterisierung
	PLA1+ 7%PBS -PLA2+ 7%PBS. -wasserstrahlverfestigt -80bar/110bar/110bar. -Faserfeinheit: 5,76dtex -Flächenmasse: 138,7g/m ²
	PLA1+PLA2 Mischung -keine Nebenkomponenten. -wasserstrahlverfestigt -110bar/185bar/185bar. -Flächenmasse: 103,3g/m ² -Schmelzpunktlt.DSC: 169,6°C -Glastemperaturlt.DSC: 63,6°C
	Filamentfeinheit 1,9 dtex Flächengewicht 113,7 g/qm Filamentdurchmesser 14 µm Luftdurchlässigkeit (DIN EN ISO 937:1995-12) - 1498

Zentrifugationsversuche

Dränage + Koaleszenz Medien

Medium G (M&H) / PLA 350

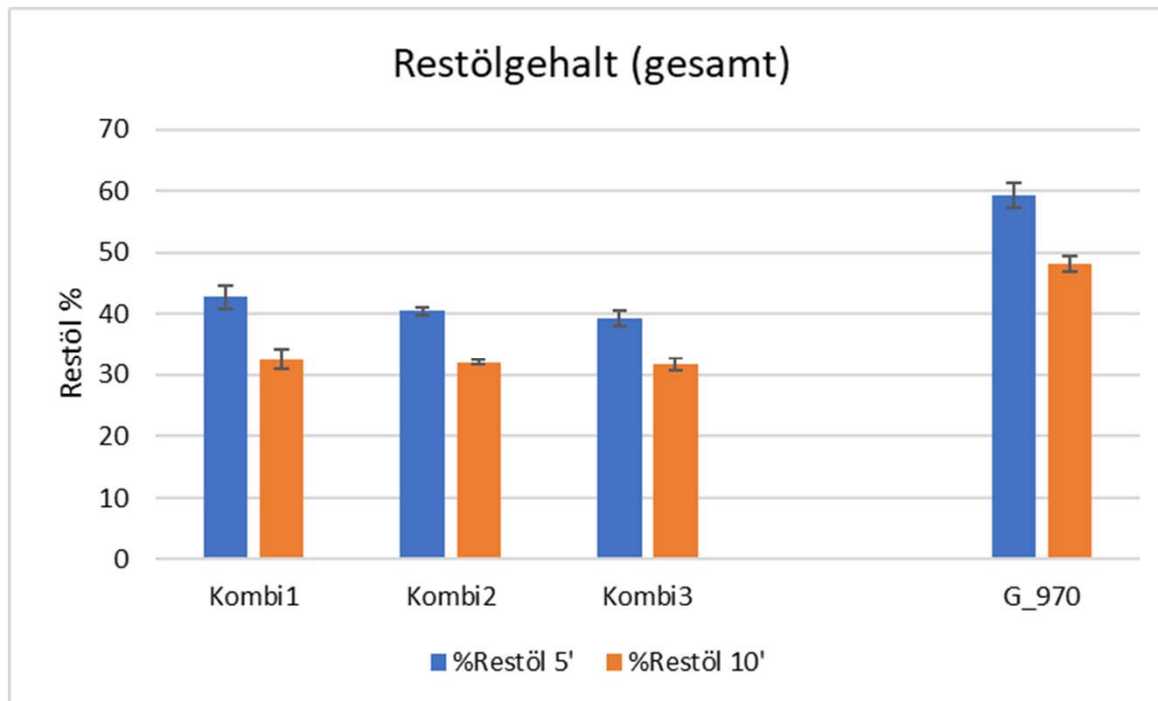


- Drainage senkrecht
- Corena-Öl
- Kapillarbenetzung
- Kasette

Zentrifugationsversuche

Dränage + Koaleszenz Medien

Medium G (M&H) / PLA 404

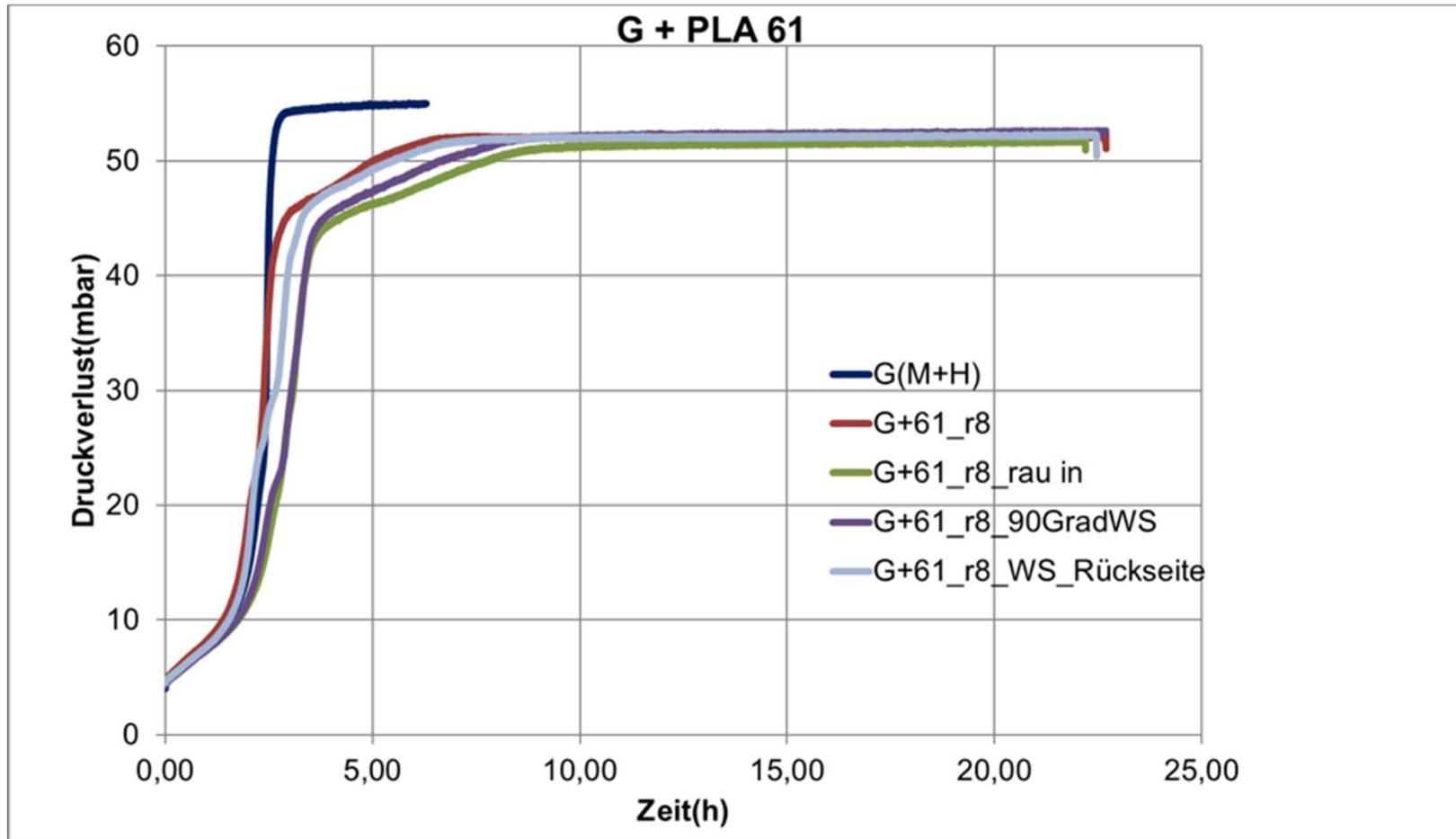


Mehrfachkombi (3-lagig): Zwei G Medien mit einzeln PLA Lage:

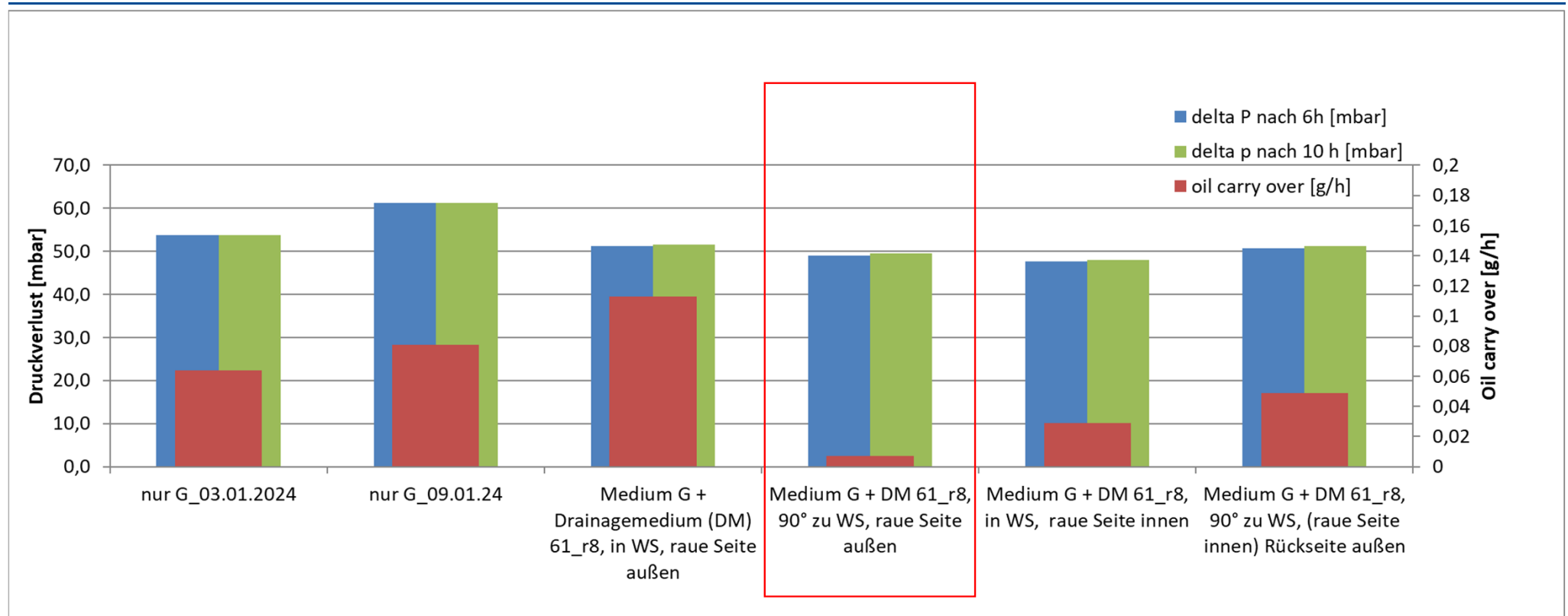
Kombi 1: Abströmseiten G auf PLA

Kombi 2: An/Abströmseite G auf PLA

Kombi 3: Anströmseiten auf PLA

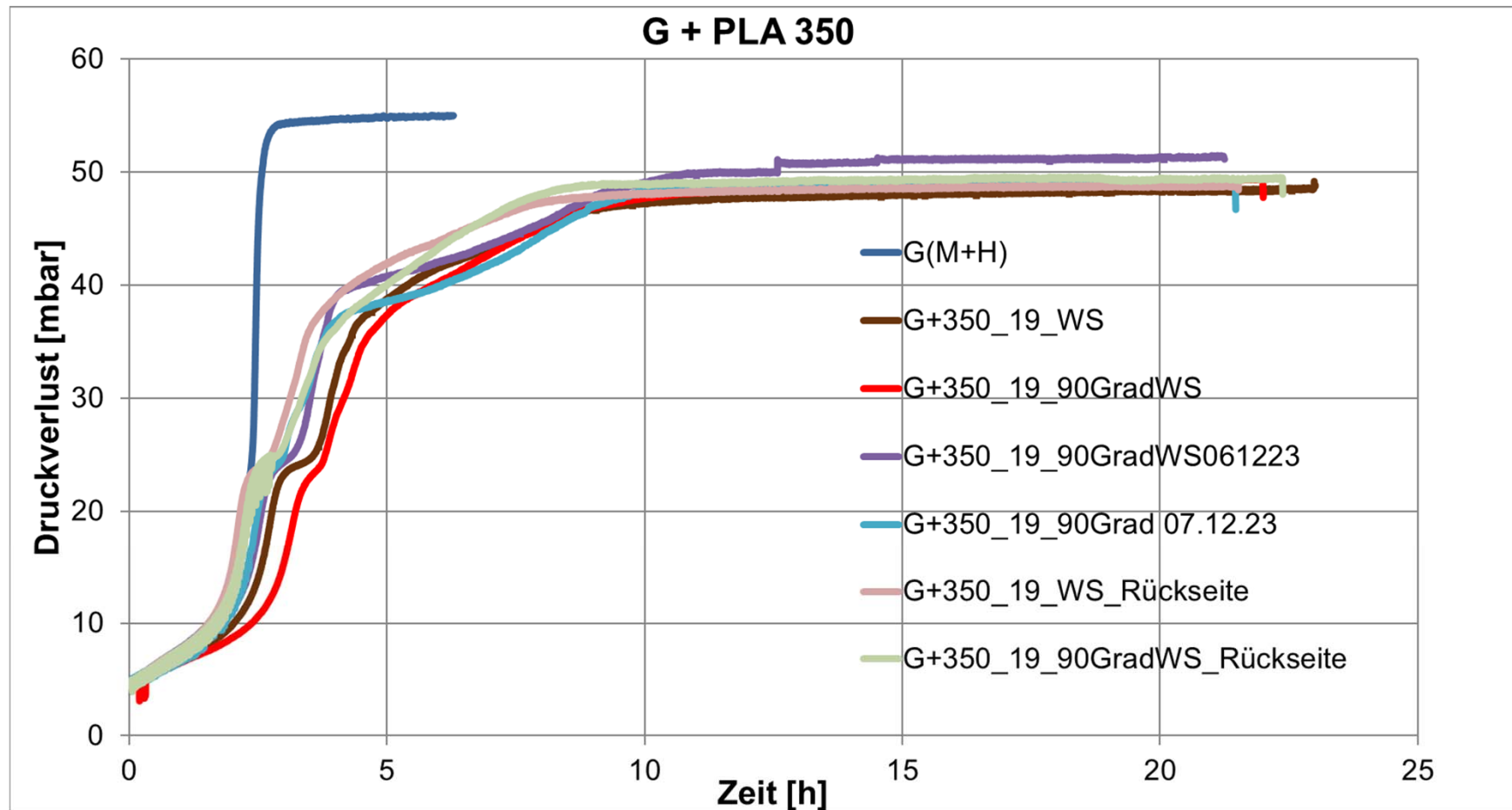


Einfluss des Drainagemediums PLA61: Oil Carry Over - Einbaurichtung

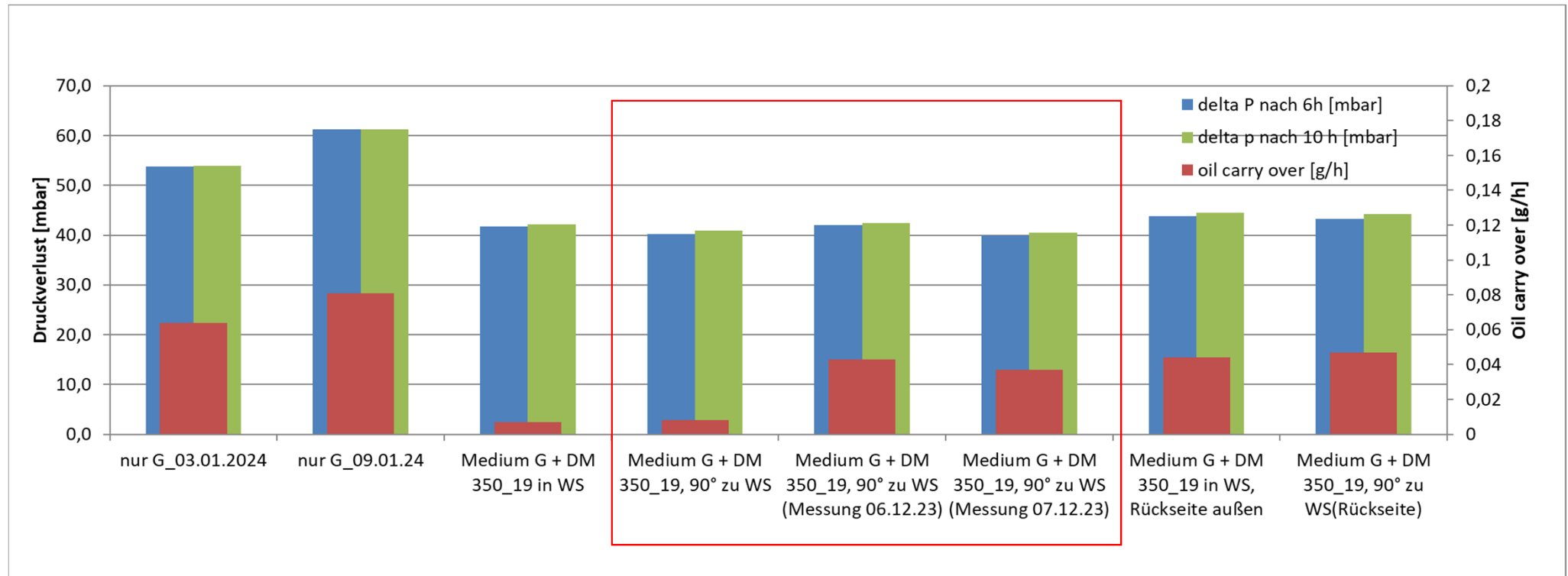


Oil Carry Over ist von der Einbaurichtung abhängig.

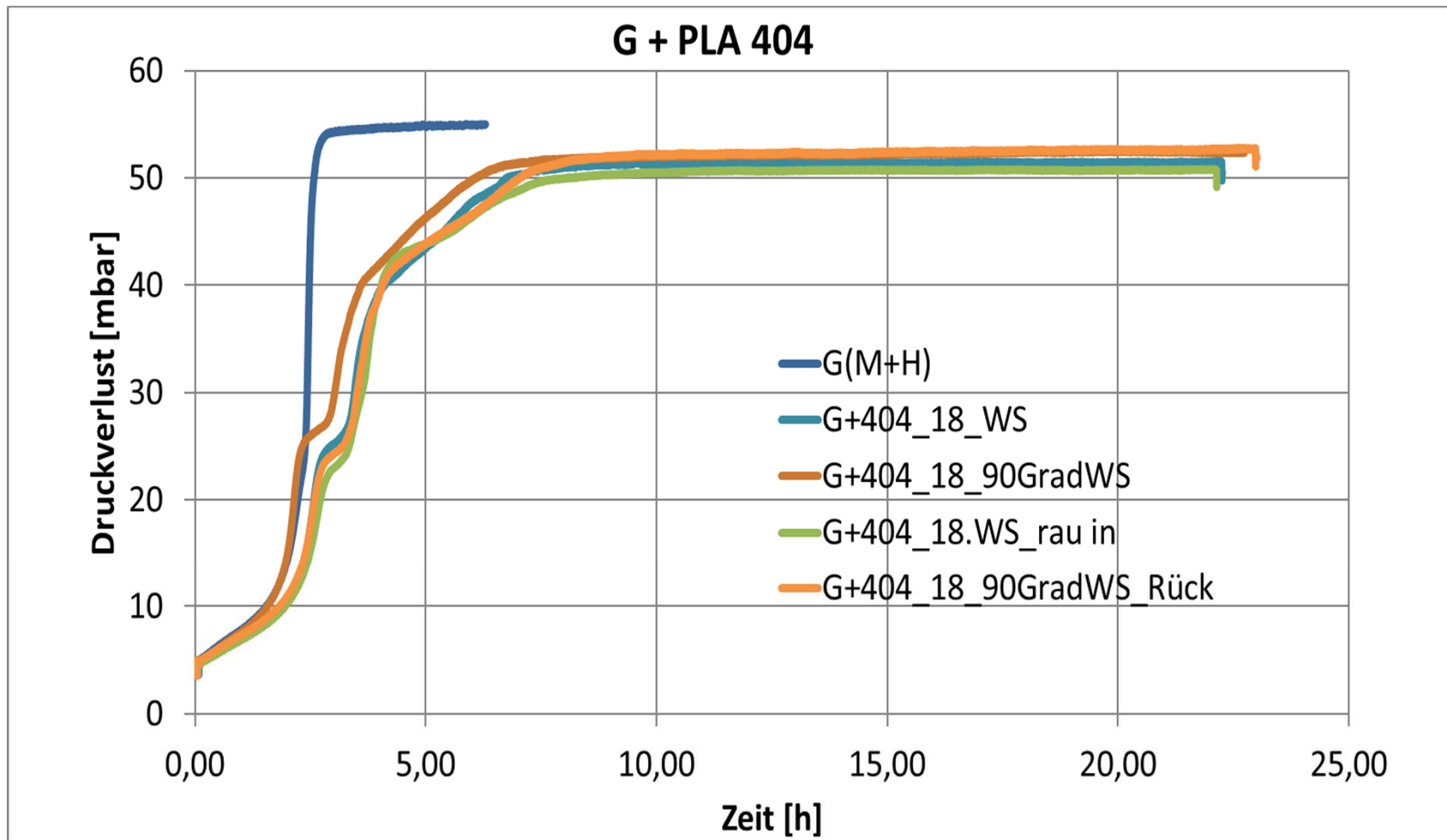
Raue Seite der DM beeinflusst OCO



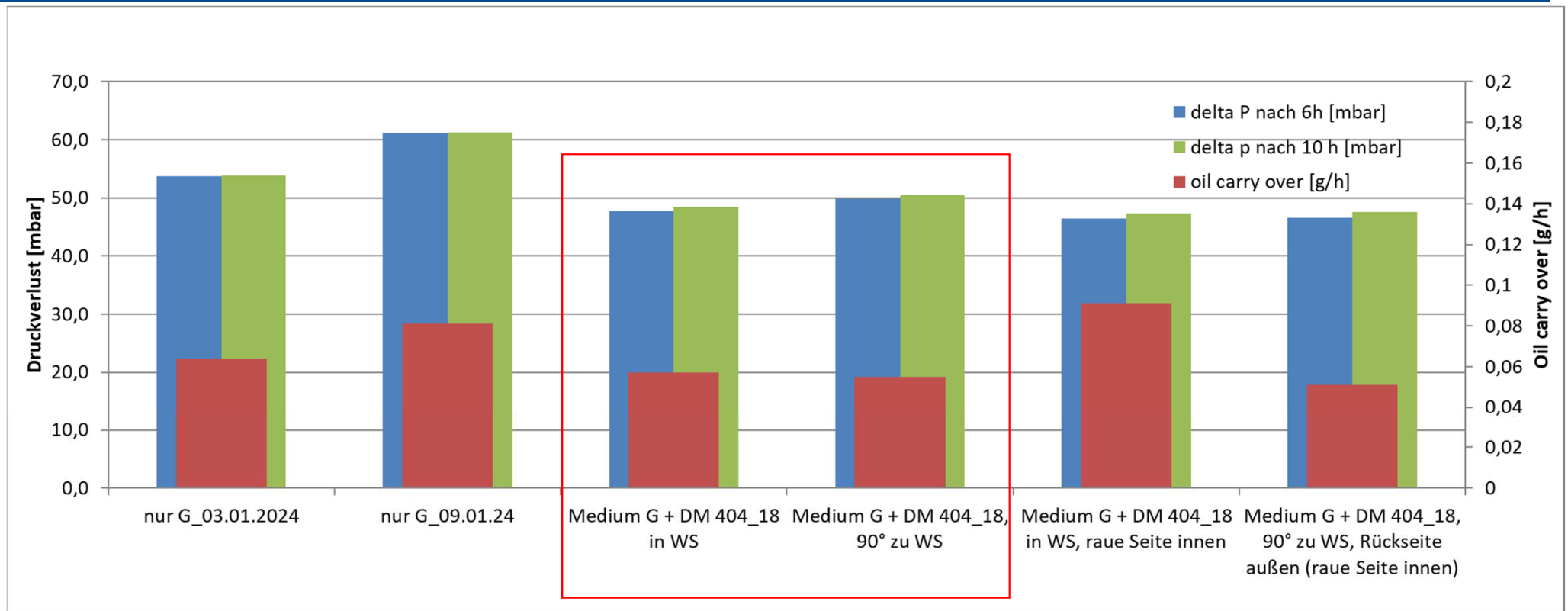
Einfluss des Drainagemediums PLA350: Oil Carry Over - Einbaurichtung



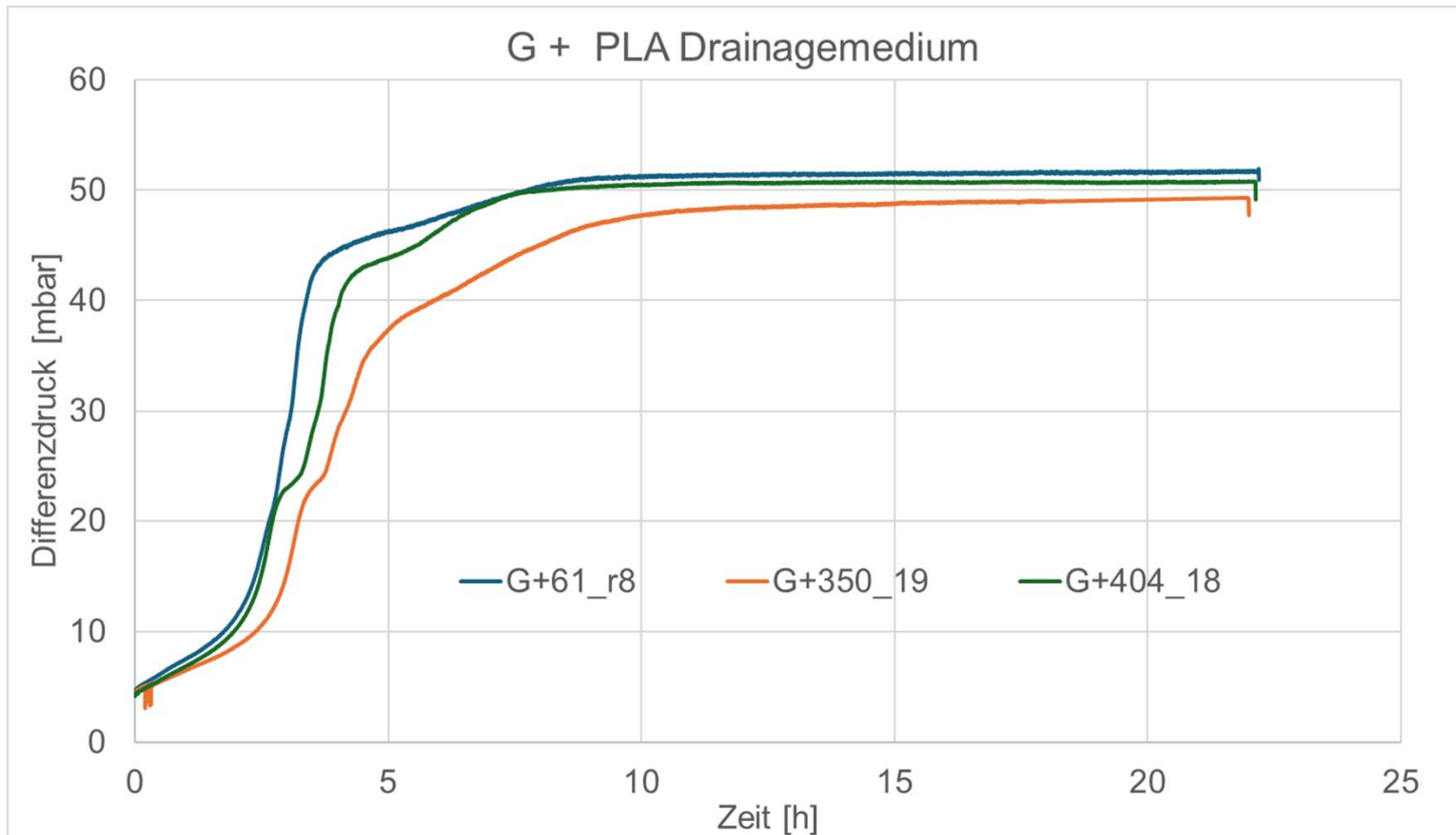
Raue Seite der DM beeinflusst OCO



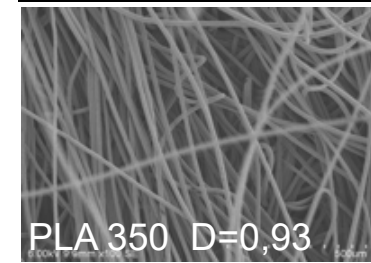
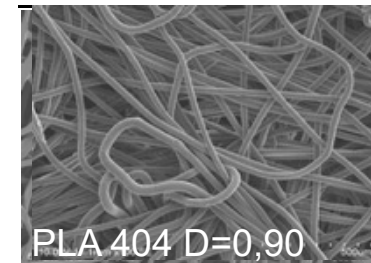
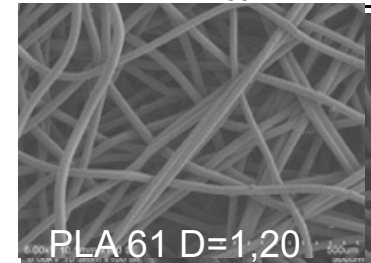
Einfluss des Drainagemediums PLA 404: Oil Carry Over - Einbaurichtung



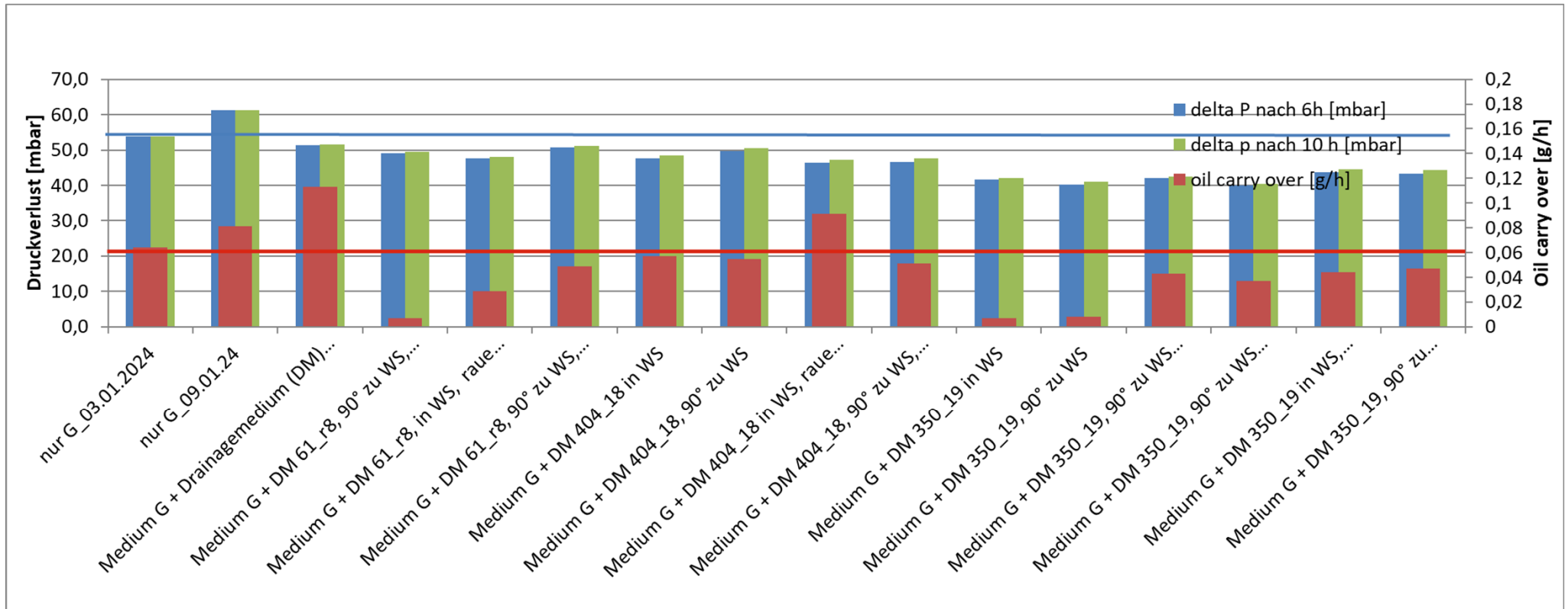
Einfluss des Drainagemediums



Spinnvliesstoffe aus PLA
(STFI)
REM 100x



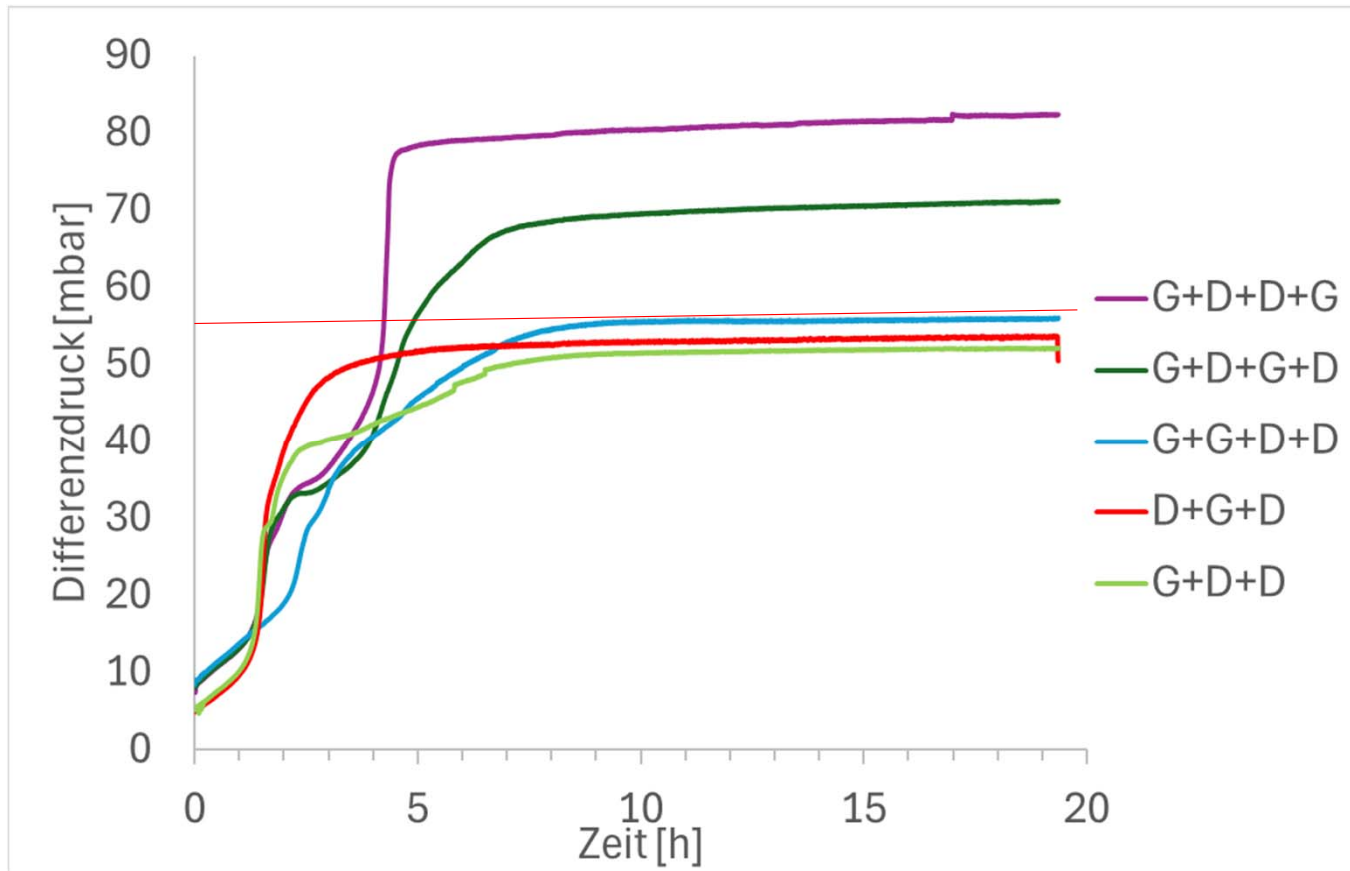
Oil carry over



Mit PLA Drainagemedien werden geringere Differenzdrücke als allein mit G Medium erzielt, Je nach Einbaurichtung ebenfalls geringeres Oil Carry Over. PLA 350 zeigt tendenziell die größte Verringerung in delta p.

Kombinationen G + Drainage PLA350

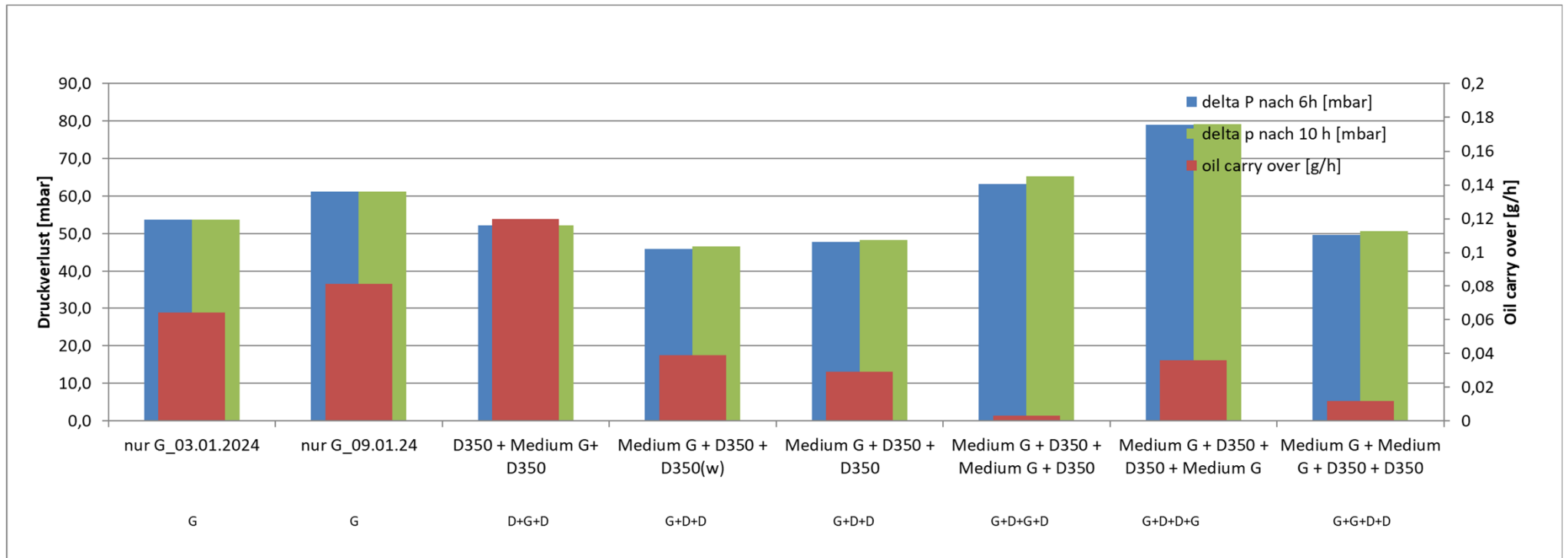
D= Drainagemedium PLA 350; G= G-Medium (M+H)



Kombinationen G + Drainage PLA350



D= Drainagemedium PLA 350; G= G-Medium (M+H)



Einfluss des Öltyps (Viskosität)



	Oil carry over [g/h]	Öl-Konzentration AG [mg/m ³]	Öl-Eingangs- konzentration am Filter [mg/m ³]	Ölmassenstrom AG [g/h]	Abtropfmassen- strom aus Diagramm [g/h]
Ondina 917					
G +PLA 350 (M1) in WS	0,30	520	463	2,26	1,71
G + PLA 350 (M2) in WS	0,20	529	493	2,30	1,94
G	0,69	457	569	2,48	1,30
Corena S3 R46					
G + PLA 350 in WS	0,01	160	123	0,70	0,53
G + PLA 350 90° zu WS	0,04	168	148	0,73	0,60
G (M1)	0,06	180	153	0,78	0,60
G (M2)	0,08	176	154	0,76	0,59

Vorläufige Ergebnisse der Untersuchungen: Bei gleichen Volumenstromereinstellungen delta p in ähnlichem Bereich, aber Oil Carry Over mit Ondina Öl deutlich größer. Wiederholungsuntersuchungen notwendig.

Einfluss des Öltyps (Viskosität)



Corena S3 R46

Typische Kennwerte

Eigenschaften	Norm	Shell Corena S3 R 46
ISO Viskositätsklasse	ISO 3448	46
Kinematische Viskosität @40°C	ASTM D445	46 mm ² /s
Kinematische Viskosität @100°C	ASTM D445	6,9 mm ² /s
Viscosity Index	ISO 2909	105
Dichte @15°C	ASTM D 1298	868 kg/m ³
Flammpunkt (COC)	ASTM D 92	230 °C
Luftabscheidevermögen	ASTM D 3427	3 Minuten
RPVOT	ASTM D 2272	700 Minuten
FZG Prüfverfahren	Schadenskraftstufe CEC-L-07-A-95	11
Pour Point	ASTM D 97	-30 °C
Wasserabscheidevermögen @54°C	ASTM D 1401	15 Minuten

Typische Kennwerte aus der aktuellen Produktion. Durch Weiterentwicklung von Produkt und Produktion bedingte Datenveränderungen bleiben vorbehalten.

Ondina 917

Typische Kennwerte

Ondina 917		
Farbe Saybolt	DIN 51411	+30
Dichte bei 15°C	kg/m ³ DIN EN ISO 12185	854
Brechzahl bei 20°C	DIN 51423-1	1,468
Flammpunkt COC	°C DIN ISO 2592	200
Pourpoint	°C DIN ISO 3016	-15
Kinematische Viskosität	DIN EN ISO 3104	
bei 20°C	mm ² /s	42
bei 40°C	mm ² /s	18
bei 100°C	mm ² /s	3,7
Schwefelgehalt (RFA)	m-% DIN EN ISO 14596	< 0,001
Anilinpunkt	°C DIN ISO 2977	106
Kohlenstoffverteilung	DIN 51378/ oder ASTM D 2140 mod.	
C/A (S-korr.)	%	0
C/N (S-korr.)	%	34
C/P (S-korr.)	%	66
VDK		0,806
r _i		1,0430
Verdampfungsverlust (22 h bei 107°C)	m-% ASTM D 972	1,0
Reinheitsanforderungen an Medizinisches Weißöl	US FDA § 172.878/ 178.3620 (a) EU PHARM III	erfüllt erfüllt
Verdampfungsverlust nach Noack (1 h bei 250 °C)	m-% DIN 51581	35

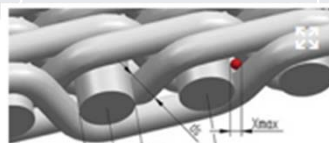
Durch Weiterentwicklung von Produkt und Produktion bedingte Datenveränderungen bleiben vorbehalten.

Metallgewebe als Drainagemedium

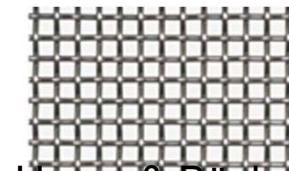
1. Vergleich unterschiedlicher Gewebetypen

- Quadratische und Tressen-Gewebe.
- Unterschiedliche Porenweiten und Drahtstärken

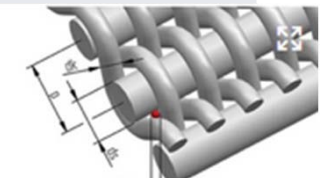
Gewebebezeichnung	DTW 14S	DTW 45S	DTW 90S	w=0,4, d=0.25	RPD90S
Eigenschaften	Tressen- gewebe	Tressen- gewebe	Tressen- gewebe	Quadrat- maschen	Tressen- gewebe
Feinheit	15 μm	40 μm	90 μm		90 μm
Porengröße	14 μm	46 μm	88 μm		90 μm
Meshcount	200 x 1400	80 x 700	40 x 560		174 x 45
Maschenweite:				0,4 mm	
Drahtdurchmesser:				0,25 mm	



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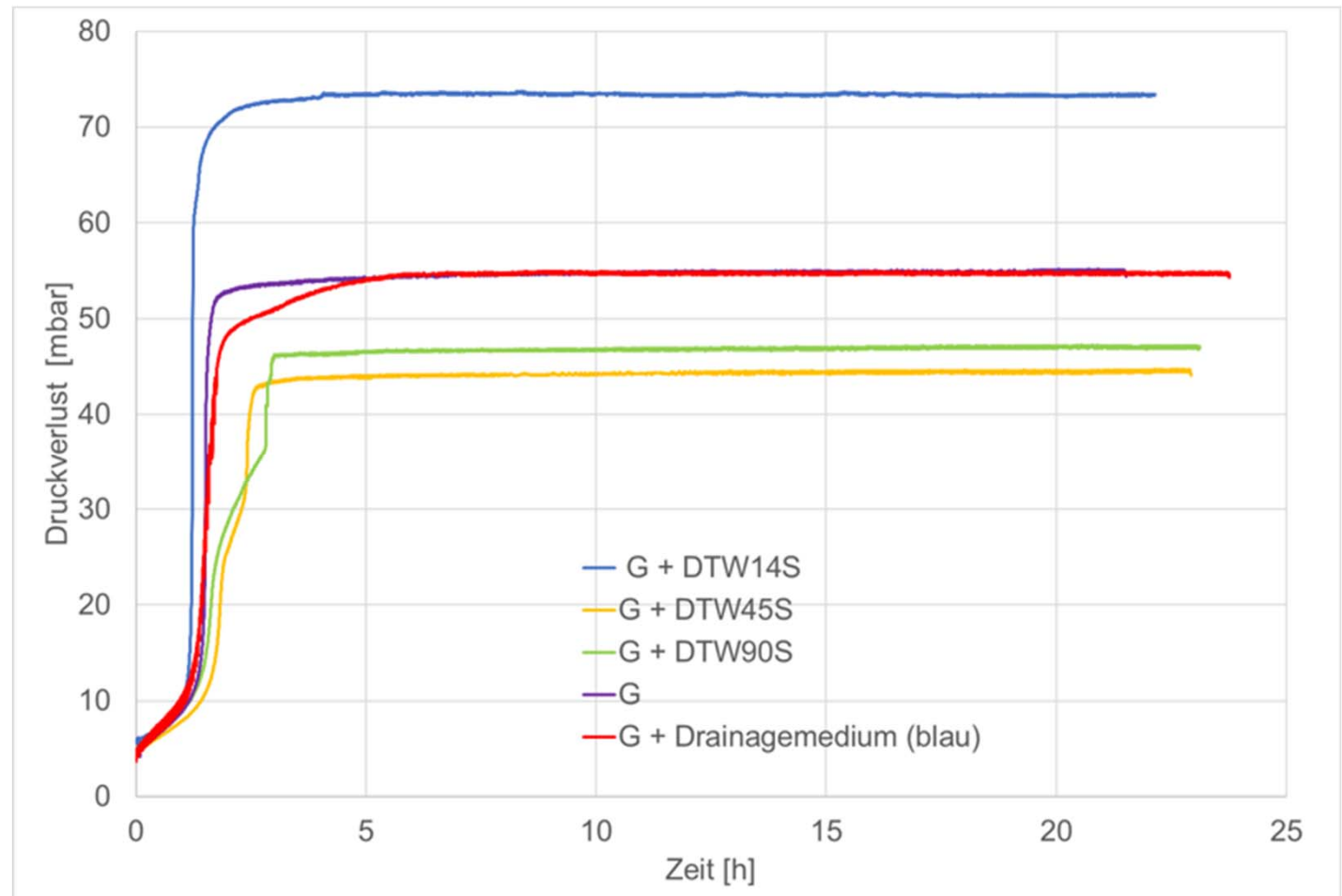


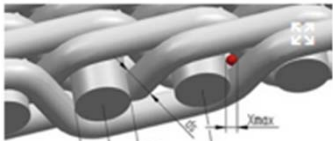
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Metallgewebe als Drainagemedium – delta p



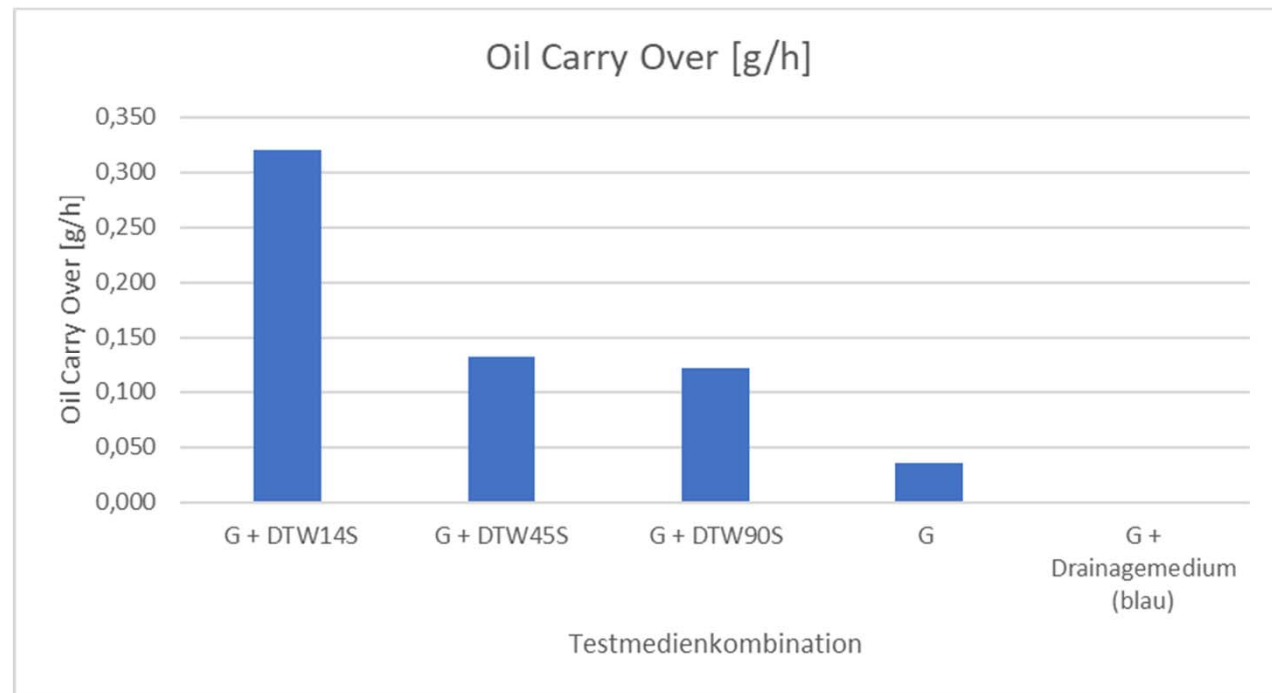
Verringerung des
Druckverlustes in
Sättigung ~20%



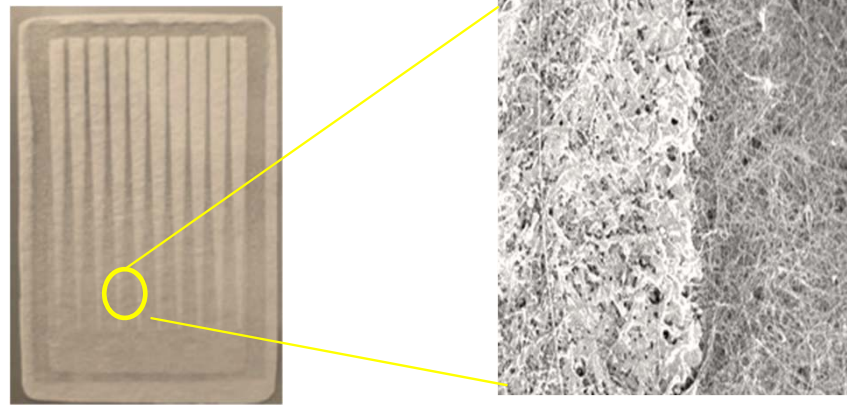


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Verringerung des Druckverlustes in Sättigung ~20%, aber höheres Oil Carry Over, insbesondere bei kleinen Poren.



Ursprüngliches Konzept



Kanalisation der Öldrainage
auf mesoskopischer Ebene:

Koaleszenzmedia:

- Gemusterte Oberfläche (in sub mm bis 5 mm Feinheit.
- Tiefe des Musters
- Kombination von fein- und grobporigen Schichten
- Integration von Drainagemedien

Drainagemedia

- Konstruktion: Schaumstoff, technische Gewebe, Vliesstoffe mit ausgerichteten Fasern
- Einfluss des Musters auf die Reingasseite des Drainagemediums
(AP 2,3,4,5)

Maßgeschneiderte Modifikation der
Medien:

Optimierung der Muster:

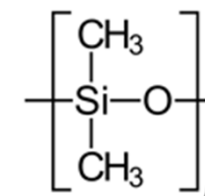
- Einfluss der lateralen Feinheit und der Eindringtiefe während des Modifikationsprozesses
- Erzeugung von Benetzungsgradienten mit fluorarmen und fluorfreien Formulierungen
- Quantitative Bewertung der Mindestmenge der aktiven Fluorkomponente zur Beschleunigung der Entwässerung

(AP 3, 4, 5)

Ansatz zum chemischen Maßschneidern der Medien

Polydimethylsiloxan (PDMS) Verbindungen zur Herstellung von Mustern

	MagnaSoft 2059	SM 2112	MagnaSoft DerMa	SilSoft CLX	Silquest A2387	Baysilone OF TP3309
Kürzel	M. 2059	SM2112	M. DerMa	SilSoft	A2387	TP3309
Chemisch	Aminomethyl-polysiloxan	Polydimethyl-siloxan	Quarternäres Aminosiloxan	Polydimethyl-siloxan (INCI: Dipropylene Glycol (and) Polysilicone-29)	Silyliertes Polyazamid	Aminofunktionelles Polyorganosiloxan
Strukturbe-sonderheiten	Amino-Gruppen	Nur OH-Endgruppen	Quats		N	Ethoxygruppen
Gehalt	35% Emulsion	35% Emulsion	35% Emulsion (2 Emulgatoren)	15% Si-Verbindung	50%	20% (selbst hergestellt)
Löse-/Disper-sionsmittel	Wasser	Wasser	Wasser	Wasser	Ethanol	Wasser
Trocknung	130°C, 3 Min.	130°C, 3 Min.	130°C, 3 Min.	60°C, 3 Min.	Not used	130°C, 3 Min.

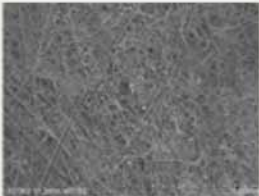
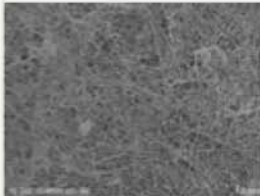
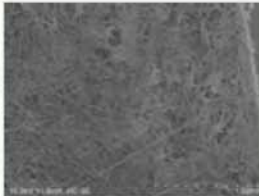
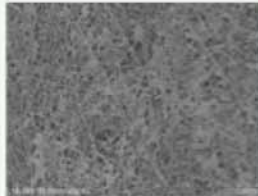
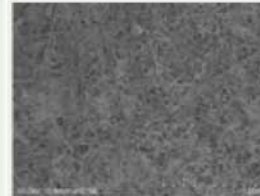
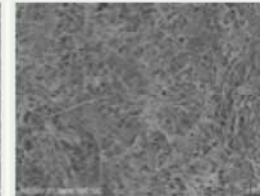
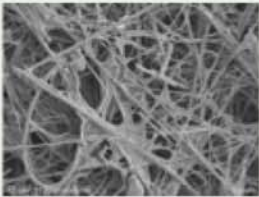
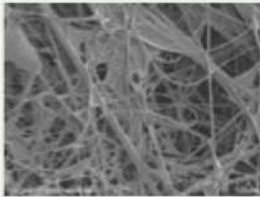
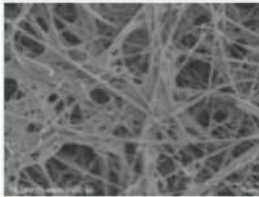
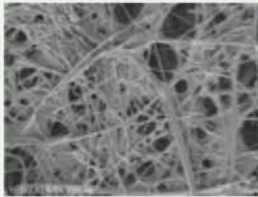
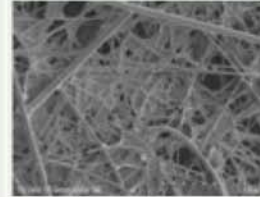
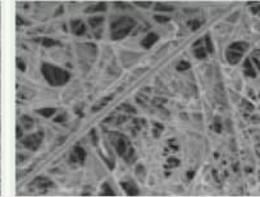

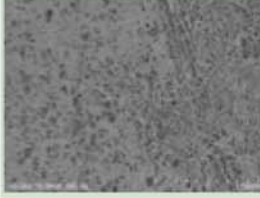
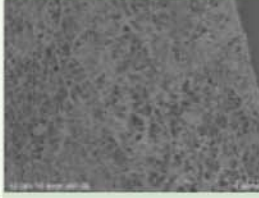

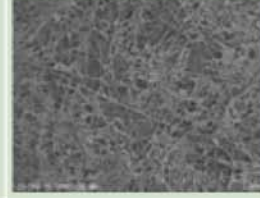
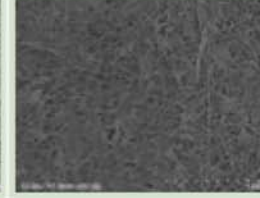
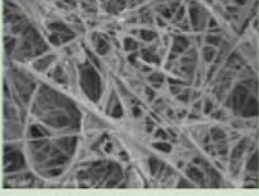
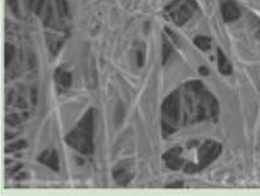
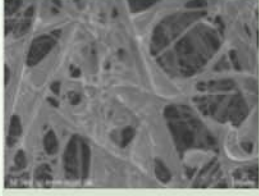
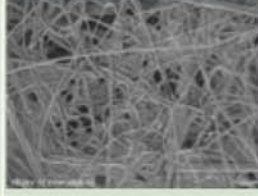
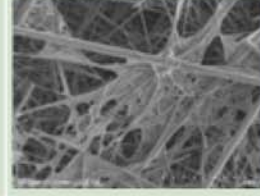
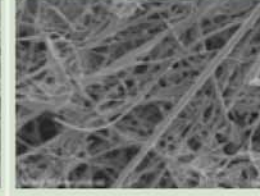


GF-Filter	Orig.	Abw	10 wt%	Abw	5 wt%	Abw	2.5 wt%	Abw	1 wt%	Abw
M. 2059	< 10 s		00:39	00:08	/	/	/	/	00:59	00:10
SM2112		< 10 s		/	/	/	/	< 10 s		
M. DerMa		00:23	00:04	00:25	00:08	00:21	00:05	/	/	
SilSoft CLX		02:16	00:18	01:23	00:24	00:41	00:15	/	/	
TP3309		< 10 s		< 10 s		< 10 s		/	/	

Benetzungsverhalten: Einsinkzeiten Öl

Ansatz zum chemischen Maßschneidern der Medien

1. REM-Aufnahmen: GF M&H (Medium G)

Gew%	Auflösung	Original	M. 2059	SM2112	M. DerMa	SilSoft CLX	TP3309
1% (für M. 2059 & SM 2112)	50						
	2,5% 500						
10%	50						
	500						

1. Zentrifugation

- Strukturelle und Oberflächeneigenschaften lassen sich trennen
- Zusammenhänge bedürfen weiterer Untersuchungen unter Verwendung von Medien bekannter struktureller Zusammensetzung und Oberflächeneigenschaften

2. Silikonmodifizierung

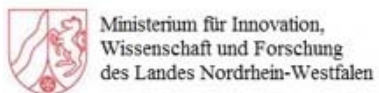
- Reduktion des Sättigungsdifferenzdrucks möglich
- Optimierung notwendig
 - Muster
 - Trocknung
 - Konzentration
 - Applikation

Danksagung

Vielen Dank an Kollegen und Projektpartner:

IUTA: Burkhard Stahlmecke, David Habryka, Noa Preker, Alexandra Mafodjo Kamga, Hannaneh Yousefi Jolandan, Christof Asbach

DTNW: Beate Gebert, Larissa Jakzis



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Europäischer Fonds
für regionale Entwicklung

Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

IGF-Projekt-Nr. 22356 N

aufgrund eines Beschlusses
des Deutschen Bundestages