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# Melt Blowing

Equipment, Technology,  
and Polymer Fibrous Materials

With 105 Figures and 21 Tables



Springer

Prof. L. S. Pinchuk  
Prof. V. A. Goldade  
Prof. A. V. Makarevich  
V. A. Belyi Metal-Polymer Research Institute  
of the National Academy of Sciences of Belarus  
32a Kirov Street  
246050 Gomel  
Belarus

Prof. V. N. Kestelman  
KVN International Inc.  
632 Jamie Circle  
King of Prussia, PA 19406  
USA

*Series Editors:*

Professor Dr. H. Warlimont  
Institut für Festkörper- und Werkstofforschung e.V.  
Helmholtzstrasse 20, 01069 Dresden, Germany

Professor Dr. E. Weber  
Materials Science and Mineral Engineering, University of California  
587 Evans Hall, Berkeley, CA 94720-1760, USA

Professor Dr. Walter Michaeli  
Institut für Kunststoffverarbeitung, RWTH Aachen  
Pontstraße 49, 52062 Aachen, Germany

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# Preface

One of the recently emerging techniques of fibrous materials production, melt blowing, consists of forming fibers from substances heated above their melting (crystalline) or glass transition (glass-like) point with further blowing by gas flow. The sprayed fibrous mass is then cooled to solidification either in a gas flow or upon deposition on the forming substrate.

Realized from polymers and then ceramics, the melt blowing technique has enriched materials science, engineering, and all commodity products by novel types of fibrous materials and products made from them with a unique combination of properties. The reasons for the popularity of melt blowing are the following.

The shape stability and strength of melt-blown materials and products are controllable technological parameters that depend on the diameter and the intensity of the adhesive interaction between fibers and the number of contacts between them.

The greater area of fiber surface in contrast to negligible clearances in between is the source of the uniqueness of melt-blown materials as systems whose properties are governed to a great degree by surface phenomena.

Dielectric materials manufactured by melt blowing are subjected to the rigorous effects of heat, deformation, and friction during processing which is accompanied by natural electrical polarization of fibers. The fibers are transferred into an electret state (an electret is a dielectric that preserves its electrical polarization for a long time), which makes melt-blown materials the source of a permanent electrical field.

The melt blowing technique creates new vistas for controlling the structure and properties of fibrous materials. At least four areas of control can be outlined.

First is the chemical composition of the material extruded into fibers. The second area is fiber transportation within the gas flow where the material is in a structurally sensitive state, either viscous-flow or viscoelastic. At this stage, it is convenient to modify fibers by chemical, physical, and biological methods. Third, the fiber diameter (from portions a micrometer to a millimeter) and a uniformity of the adhesion of dispersed components to the fibers can be adjusted to impart new functional properties to the material as a whole.

The fourth area is the texture of melt-blown materials and products that is determined by the mutual disposition and bonding of fibers to one another.

Development of a great variety of melt-blown materials has perceptibly impacted engineering domains and life as a whole. Following are some examples that confirm this fact.

Melt-blown materials can serve an ideal basis for biosorbents and biocatalysts in a number of biotechnological processes whose success influences their commercial prospects (biotechnology is a combination of industrial procedures using living organisms and biological processes in manufacture). Microorganisms immobilized on a fiber surface are easily accessible to reagents in liquid and gaseous phases. However, the shape stability of the fibrous carcass presents a mechanical barrier that separates microbial colonies from the environment. Weak and superweak physical fields generated by melt-blown materials also stimulate the vitality of microorganisms.

Melt-blown materials have opened new ways of solving problems in engineering ecology. Its methodology and tools require constant change in the range of filtering materials. Melt blowing technology has made it possible to simplify the problem of cleaning industrial wastewater and gas ejections, and to develop systems for entrapping petroleum products, organic solvents, heavy metal ions and to inactivate them biologically.

Recently elaborated melt-blown materials based on readily fusing glue compositions, also soft but preserving their shape lining, decorating, and other accessory materials have enriched light industry with novel techniques and products.

Melt-blown materials based on water-soluble polymers and their gels have formed the basis of a vast variety of medical, hygiene, cosmetic, and perfume products of a new generation without which modern civilization is unthinkable.

Unfortunately, despite almost a 50-year history, the melt blowing technique, for a number of reasons to be expounded further, is little known thus far. Until now, there has not been in any monograph in the literature that generalizes its objectives, means of attainment, and recent successes. What is more, the methodology, including its original tools, design of technological equipment, and instrumentation for implementing this unusual technology has not yet been elucidated. This book is the first publication where the physicochemical basis of the melt blowing technique is systematized, and fundamental flow charts, designs of the main joints, characteristics and fields of application for melt-blown materials are correlated. The authors have endeavored to describe precursors' works at length, even though the essentials of the book constitute investigations of their own completed at the Metal-Polymer Research Institute (MPRI) of the National Academy of Sciences of Belarus (Gomel, Belarus) with a Design Bureau and pilot plant.

The authors express their gratitude to MPRI's Director, Correspondent Member of NASB, Prof. Yu. M. Pleskachevsky for attention to this work;

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Gomel  
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*Leonid S. Pinchuk*  
*Victor A. Goldade*  
*Anna V. Makarevich*  
*Vladimir N. Kestelman*

# Contents

<b>1. Introduction (Historical Review)</b> .....	1
<b>2. Melt Blowing Techniques</b> .....	5
2.1 Main Technological Procedures .....	5
2.2 Modern Trends in Melt Blowing Techniques .....	10
<b>3. Equipment</b> .....	21
3.1 Spray Heads .....	21
3.1.1 Basic Designs .....	21
3.1.2 Modified Heads .....	28
3.2 Auxiliary Equipment .....	42
<b>4. Structure of Melt-Blown Polymer Fibrous Materials (PFM)</b> .....	53
4.1 Major Structural Parameters .....	53
4.2 Effect of Different Technological Regimes on PFM Structure .....	60
<b>5. Specific Properties of Melt-Blown PFM</b> .....	65
5.1 Physicochemical Characteristics .....	65
5.2 Electret Charge in Melt-Blown Materials .....	75
<b>6. Fibrous Materials in Filtration Systems</b> .....	83
6.1 Efficiency of Filtration Systems .....	83
6.2 Filtration Mechanisms .....	85
6.2.1 Mechanisms of Particle Precipitation .....	85
6.2.2 Surface and Depth Filtration .....	86
6.2.3 Electrostatic Precipitation .....	89
6.2.4 Precipitation and Coagulation in a Magnetic Field ....	91
<b>7. Electret Filtering PFM</b> .....	95
7.1 Mechanism of PFM Polarization .....	95
7.2 Capillary Phenomena .....	99



7.3	Production Process and Properties of Electret PFM	103
7.4	Applications	106
<b>8.</b>	<b>Magnetic Filtering PFM</b>	<b>111</b>
8.1	Background	111
8.2	Simulation of Magnetic Deposition in PFM	113
8.3	Theory versus Experiment	117
8.4	Magnetization of PFM	117
8.5	Magnetic Coagulation of Particles in PFM	121
8.6	Magnetic Capillary Phenomena	127
8.7	Serviceability of Magnetic PFM-Based Filters	132
<b>9.</b>	<b>Adsorptive and Microbicidal PFM</b>	<b>135</b>
9.1	PFM Modified by Porous Adsorbents	135
9.2	PFM as Adsorbents of Oil Products	137
9.3	Complex-Forming PFM	138
9.4	Adsorptive-Microbicidal PFM	143
<b>10.</b>	<b>PFM as Carriers of Microorganisms</b>	<b>147</b>
10.1	Biofilters with Polymer Fibrous Biomass Carriers	147
10.2	Effect of Magnetic Fields on the Growth Processes of Microorganisms	155
<b>11.</b>	<b>Other Applications of PFM</b>	<b>161</b>
11.1	Household Uses	161
11.2	Industry	165
11.3	Construction	168
11.4	Medicine	170
11.5	Packing	173
11.6	Protection of Products and Environment	175
<b>12.</b>	<b>Ecological and Social Problems</b>	<b>179</b>
12.1	Solution of Ecological Problems	179
12.1.1	Purification of Industrial Gases	180
12.1.2	Wastewater Purification	181
12.1.3	Melioration	182
12.1.4	Oil and Chemical Sorbents	182
12.2	Regeneration, Utilization, and Burial	184
12.3	Economic Estimates	188
<b>13.</b>	<b>Conclusion</b>	<b>191</b>
	<b>References</b>	<b>193</b>
	<b>Subject Index</b>	<b>206</b>

# List of Abbreviations

AC – activated charcoal  
AFM – atomic force microscopy  
AOIA – automatic optical image analysis  
BAPM – biological active polymer materials  
BET – Brunour–Emmet–Teller theory  
BF – barium ferrite  
BLE – birch leaves extract  
CC – coordination compounds  
CCS – chemical current source  
CNE – coniferous needles extract  
COD – chemical oxygen demand  
DEG – diethyleneglycol  
DEL – double electric layer  
DOP – dioctylphtalate  
DSC – differential scanning calorimetry  
EPR – electron paramagnetic resonance  
ESCD – efficient surface charge density  
FC – functional components  
FE – filtering element  
FM – filtering material  
FPC – fibrous polymer carriers  
FPF – fine-purification filter  
HDPE – high density PE  
HFC – high frequency current  
IRS – infra-red spectroscopy  
LDPE – low density PE  
MF – magnetic field  
MI – melt index  
MPRI – Metal-Polymer Research Institute of National Academy  
of Sciences of Belarus  
OM – optico-microscopic method  
PA – polyamide  
PAN – polyacrylonitrile  
PE – polyethylene  
PET – polyethylene terephthalate  
PF – Petryanov’s filter  
PFM – polymer fibrous materials

## XII List of Abbreviations

PHC – polynitrogen heterocyclic compounds  
PP – polypropylene  
PTFCE – polytrifluorochloroethylene  
PU – polyurethane  
PVA – polyvinylacetate  
PVC – polyvinylchloride  
SEM – scanning electron microscopy  
SF – strontium ferrite  
TSC – thermally stimulated current  
TSD – thermally stimulated depolarization  
UV – ultraviolet  
XPS – X-ray photoelectron spectroscopy  
XSMA – X-ray spectral microanalysis