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# Handbook of PHARMACEUTICAL EXCIPIENTS

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Third Edition

*Edited by*

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# Cellulose, Microcrystalline

## 1. Nonproprietary Names

BP: Microcrystalline cellulose  
JP: Microcrystalline cellulose  
PhEur: Cellulosum microcrystallinum  
USP: Microcrystalline cellulose

## 2. Synonyms

Avicel; cellulose gel; crystalline cellulose; E460; Emcocel;  
Fibrocel; Tabulose; Vivacel.

## 3. Chemical Name and CAS Registry Number

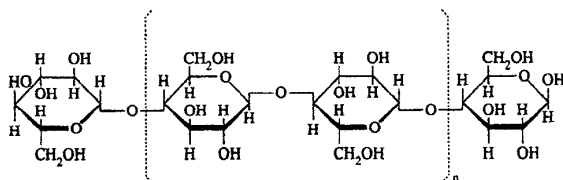
Cellulose [9004-34-6]

## 4. Empirical Formula and Molecular Weight

$(C_6H_{10}O_5)_n$   $\approx$  36 000

Where  $n \approx$  220.

## 5. Structural Formula



## 6. Functional Category

Adsorbent; suspending agent; tablet and capsule diluent; tablet disintegrant.

## 7. Applications in Pharmaceutical Formulation or Technology

Microcrystalline cellulose is widely used in pharmaceuticals, primarily as a binder/diluent in oral tablet and capsule formulations where it is used in both wet granulation and direct-compression processes.<sup>(1-7)</sup> In addition to its use as a binder/diluent, microcrystalline cellulose also has some lubricant<sup>(8)</sup> and disintegrant properties that make it useful in tableting.

Microcrystalline cellulose is also used in cosmetics and food products.

Use	Concentration (%)
Adsorbent	20-90
Anti-adherent	5-20
Capsule binder/diluent	20-90
Tablet disintegrant	5-15
Tablet binder/diluent	20-90

## SEM: 1

Excipient: Microcrystalline cellulose  
Manufacturer: Penwest Pharmaceuticals  
Lot: 98662  
Magnification: 100x



## 8. Description

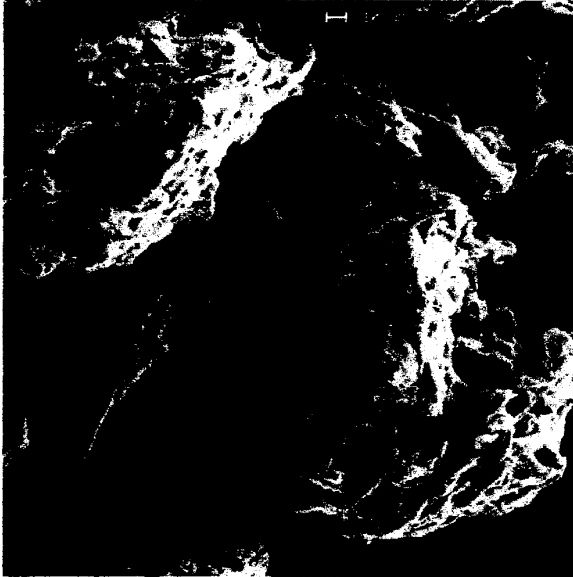
Microcrystalline cellulose is a purified, partially depolymerized cellulose that occurs as a white, odorless, tasteless, crystalline powder composed of porous particles. It is commercially available in different particle sizes and moisture grades which have different properties and applications.

## 9. Pharmacopeial Specifications

Test	JP	PhEur	USP
Identification	+	+	+
Characters	+	+	—
pH	5.0-7.0	5.0-7.5	5.0-7.0
Bulk density	+	—	+
Solubility	—	+	—
Loss on drying	$\leq$ 7.0%	$\leq$ 6.0%	$\leq$ 7.0%
Residue on ignition	$\leq$ 0.05%	—	$\leq$ 0.05%
Conductivity	+	—	+
Sulfated ash	—	$\leq$ 0.1%	—
Ether-soluble substances	$\leq$ 0.05%	$\leq$ 0.05%	$\leq$ 0.05%
Water-soluble substances	$\leq$ 0.24%	$\leq$ 0.25%	$\leq$ 0.24%
Heavy metals	$\leq$ 10 ppm	$\leq$ 10 ppm	$\leq$ 0.001%
Starch	—	+	—
Organic volatile impurities	—	—	+
Microbial limits	+	+	+
Assay	—	—	97.0-102.0%

**SEM: 2**

Excipient: Microcrystalline cellulose  
 Manufacturer: Penwest Pharmaceuticals  
 Lot: 98662  
 Magnification: 300x

**10. Typical Properties**

Angle of repose: 34.4° for Emcocel 90M.<sup>(9)</sup>

Density (bulk):

0.337 g/cm<sup>3</sup>;<sup>(a)</sup>

0.32 g/cm<sup>3</sup> for Avicel PH-101;<sup>(10)</sup>

0.29 g/cm<sup>3</sup> for Emcocel 90M.<sup>(9)</sup>

Density (tapped):

0.478 g/cm<sup>3</sup>;<sup>(a)</sup>

0.45 g/cm<sup>3</sup> for Avicel PH-101;<sup>(10)</sup>

0.35 g/cm<sup>3</sup> for Emcocel 90M.<sup>(9)</sup>

Density (true): 1.512-1.668 g/cm<sup>3</sup>;<sup>(a)</sup>

Compressibility: See Figs. 1, 2, and 3.<sup>(a)</sup>

Mechanical properties<sup>(a)</sup>

Compression pressure:	9.84 kN/cm <sup>2</sup>
Tensile strength:	0.8711 kN/cm <sup>2</sup>
Permanent deformation pressure:	15.3
Brittle fracture index:	0.0821
Bonding index:	0.0571
Reduced modulus of elasticity:	1472

Flowability: 1.41 g/s for Emcocel 90M.<sup>(9)</sup>

Melting point: chars at 260-270°C.

Moisture content: typically, less than 5% w/w. However, different grades may contain varying amounts of water. Microcrystalline cellulose is hygroscopic.<sup>(11)</sup> See Fig. 4<sup>(a)</sup> and Table I.

Particle size distribution: typical mean particle size is 20-200 μm. Different grades may have a different nominal mean particle size, see Table I.

Solubility: slightly soluble in 5% w/v sodium hydroxide solution; practically insoluble in water, dilute acids, and most organic solvents.

Specific surface area:

1.06-1.12 m<sup>2</sup>/g for Avicel PH-101.<sup>(a)</sup>

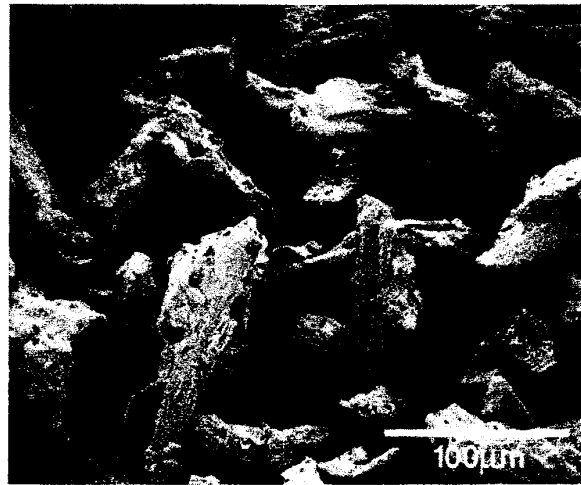
1.21-1.30 m<sup>2</sup>/g for Avicel PH-102.<sup>(a)</sup>

0.78-1.18 m<sup>2</sup>/g for Avicel PH-200.<sup>(a)</sup>

<sup>(a)</sup> Results of laboratory project for third edition.

**SEM: 3**

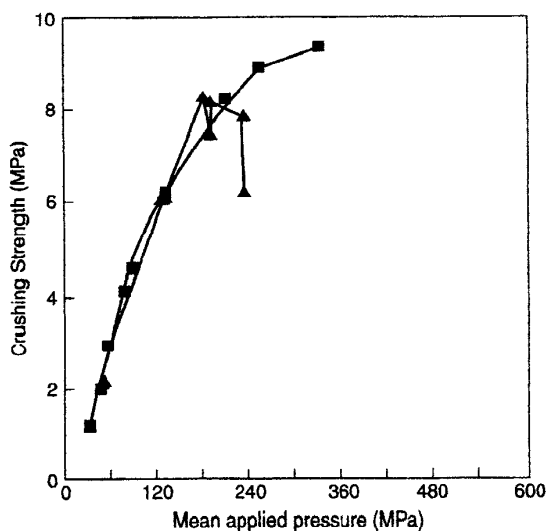
Excipient: Microcrystalline cellulose  
 Manufacturer: FMC Corp  
 Magnification: 100x



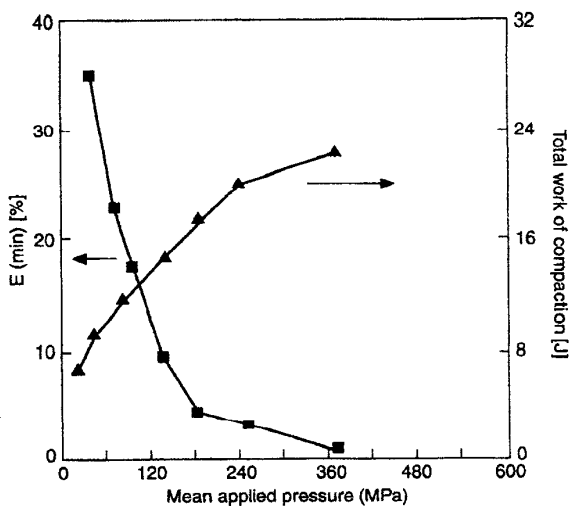
**Table I: Properties of some commercially available grades of microcrystalline cellulose.**

Grade	Nominal mean particle size (μm)	Particle Size Analysis		Moisture content (%)
		Mesh size	Amount retained (%)	
Avicel PH-101 <sup>(a)</sup>	50	60	≤ 1.0	≤ 5.0
		200	≤ 30.0	
Avicel PH-102 <sup>(a)</sup>	100	60	≤ 8.0	≤ 5.0
		200	≥ 45.0	
Avicel PH-103 <sup>(a)</sup>	50	60	≤ 1.0	≤ 3.0
		200	≤ 30.0	
Avicel PH-105 <sup>(a)</sup>	20	400	≤ 1.0	≤ 5.0
Avicel PH-112 <sup>(a)</sup>	100	60	≤ 8.0	≤ 1.5
Avicel PH-113 <sup>(a)</sup>	50	60	≤ 1.0	≤ 1.5
		200	≤ 30.0	
Avicel PH-200 <sup>(a)</sup>	180	60	≥ 10.0	≤ 5.0
		100	≥ 50.0	
Avicel PH-301 <sup>(a)</sup>	50	60	≤ 1.0	≤ 5.0
		200	≤ 30.0	
Avicel PH-302 <sup>(a)</sup>	100	60	≤ 8.0	≤ 5.0
		200	≥ 45.0	
Emcocel 50M <sup>(b)</sup>	51	60	≤ 0.25	≤ 5.0
		200	≤ 30.0	
Emcocel 90M <sup>(b)</sup>	91	60	≤ 8.0	≤ 5.0
		200	≥ 45.0	
Vivacel 101 <sup>(c)</sup>	50	50	≥ 35.0	≤ 5.0
		150	≤ 10.0	
Vivacel 102 <sup>(c)</sup>	100	50	≥ 50.0	≤ 5.0
		150	≤ 30.0	
Vivacel 12 <sup>(c)</sup>	180	50	≥ 70.0	≤ 5.0
		500	≤ 1.0	
Vivacel 20 <sup>(c)</sup>	20	50	≤ 2.0	≤ 5.0
		150	≤ 0.1	

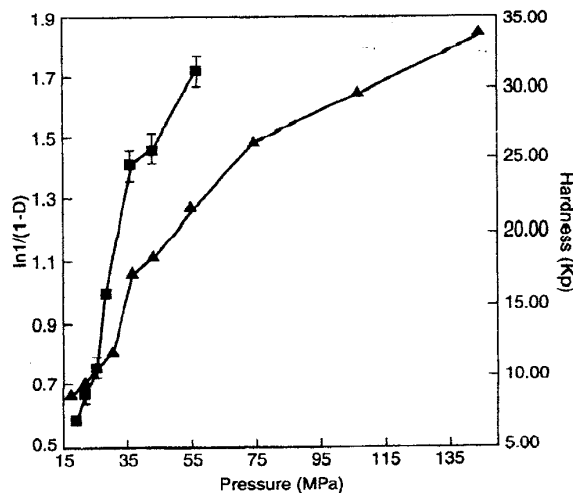
Suppliers: <sup>(a)</sup> FMC Corporation; <sup>(b)</sup> Edward Mendell Co Inc; <sup>(c)</sup> J. Rettenmaier & Söhne GmbH



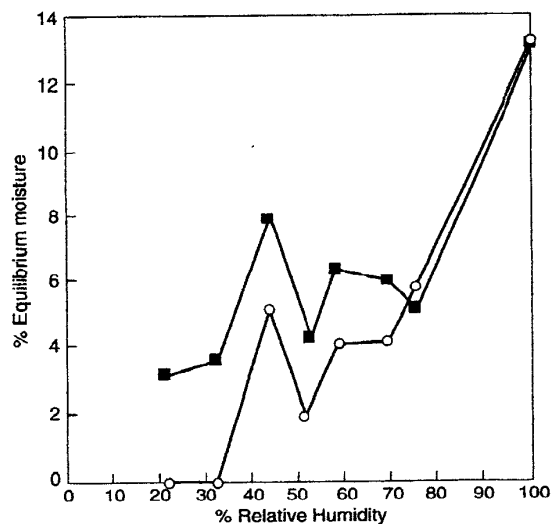
**Fig. 1: Crushing strength.**  
 (Reprinted with permission from Marcel Dekker, Inc., to be published in *Compaction of Pharmaceutical Excipients* by Metin Celik, in press, 1999.)  
 ■ : Microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X, Mendell) at  $V = 100$  mm/s  
 ▲ : Microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X, Mendell) at  $V = 300$  mm/s



**Fig. 2: Total work of compaction.**  
 (Reprinted with permission from Marcel Dekker, Inc., to be published in *Compaction of Pharmaceutical Excipients* by Metin Celik, in press, 1999.)  
 ■ : Percentage porosity (E) vs. pressure plot for microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X, Mendell) at  $V = 100$  mm/s  
 ▲ : Total work of compaction (TWC) vs. pressure plot for microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X, Mendell) at  $V = 100$  mm/s



**Fig. 3: Heckel plot for microcrystalline cellulose.**  
 ○ :  $\ln(1/(1-D))$   
 ■ : Hardness



**Fig. 4: Sorption-desorption isotherm for microcrystalline cellulose.**  
 ○ : Sorption  
 ■ : Desorption

### 11. Stability and Storage Conditions

Microcrystalline cellulose is a stable, though hygroscopic material. The bulk material should be stored in a well-closed container in a cool, dry, place.

### 12. Incompatibilities

Incompatible with strong oxidizing agents.

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