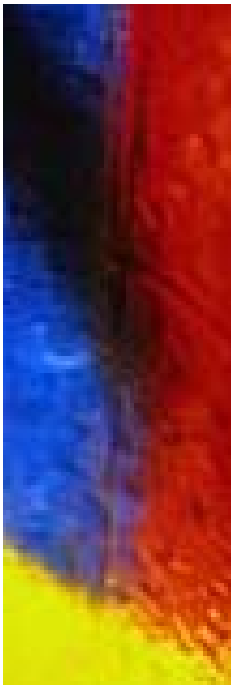
Technical Bulletin

NC105-O1E



FILM AND SHEET APPLICATIONS

IMPERM®

GRADE 105

superior gas barrier resin

Distributed by
ColorMatrix™

Nanocor®

Product Description

Imperm® is a family of superior gas barrier resins particularly useful in extending package shelf life. Grade 105 is designed for multilayer films/sheet in combination with polyethylene, polypropylene, nylon, PET, and other typical matrix resins. It is fully approved for use as a non-contact barrier layer in multilayer structures.

The base resin for Imperm is Nylon MXD6, a proven gas barrier with 25 years of industry acceptance. Imperm is created by dispersing proprietary nanoclays into MXD6 to form a nanocomposite with significantly enhanced barrier, while processing characteristics remain similar to MXD6 itself. The dispersion technology is patented.

Table 1 lists the basic properties of Imperm 105 and compares them to MXD6. Figure 1 presents a TEM photo illustrating Imperm's nanoclay distribution.

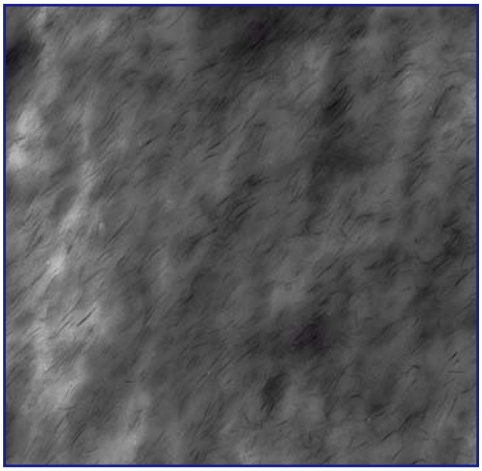


Figure 1
Nanoclay Dispersion

Table 1
Basic properties

Item		Unit	Imperm 105	MXD6
Density	non-crystallized		1.21	1.18
	crystallized		1.24	1.21
Glass transition (Tg)		° C	85	85
Melting point		° C	237	237
Semi-crystallization time[1)]		Sec	25	100
Haze[2)]		%	1.5	1.4
Tensile strength[2)]		MPa	89	85
Tensile elongation[2)]		%	2.6	3.3
Tensile modulus[2)]		GPa	4.4	3.1

[1)] During heating up to 180° C

[2)] Non-oriented film of 50 micron thickness

Gas Barrier Properties

Nanoclays exist as discrete planar sheets with aspect ratios exceeding 250. The uniform dispersion of these sheets in Imperm enhances barrier by creating a tortuous path for gas molecule permeation. Barrier improvement is universal for all permeating gases. The improvement is seen across a broad range of relative humidities. The shape of Imperm's permeation curve is relatively flat, indicating low sensitivity to moisture. Remarkable barrier is seen at humidities exceeding 70%.

Figure 2
Oxygen barrier versus relative humidity
Non-oriented films @ 23°C

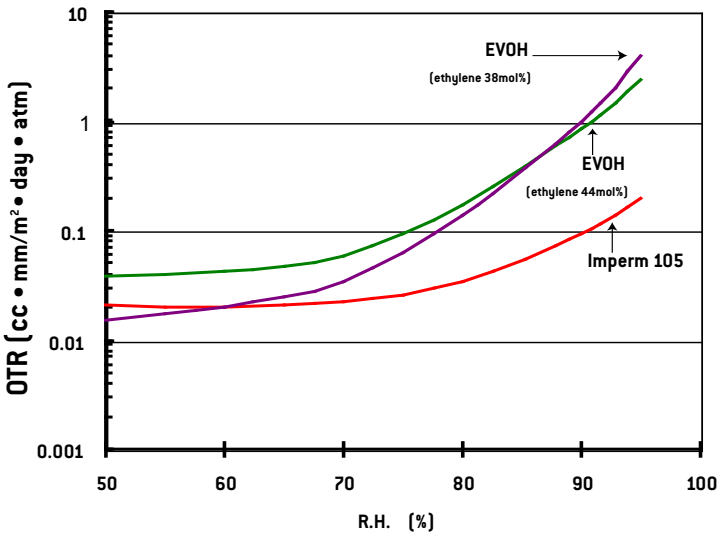


Figure 3
Oxygen barrier versus relative humidity
Non-oriented films @ 23°

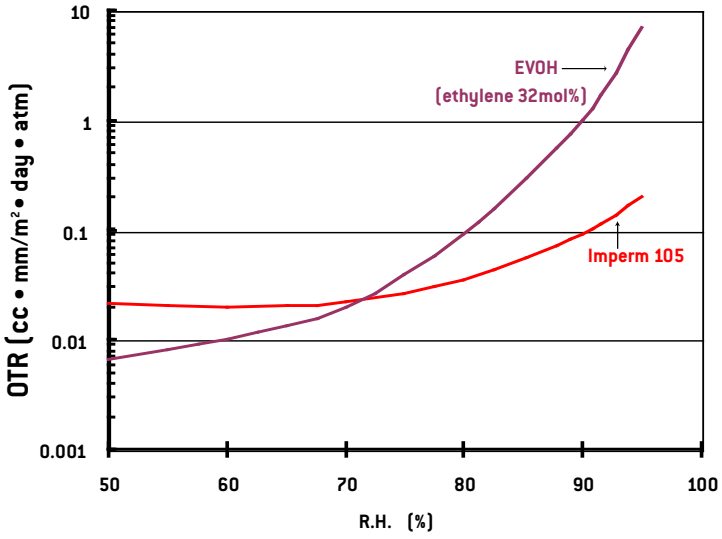


Table 2

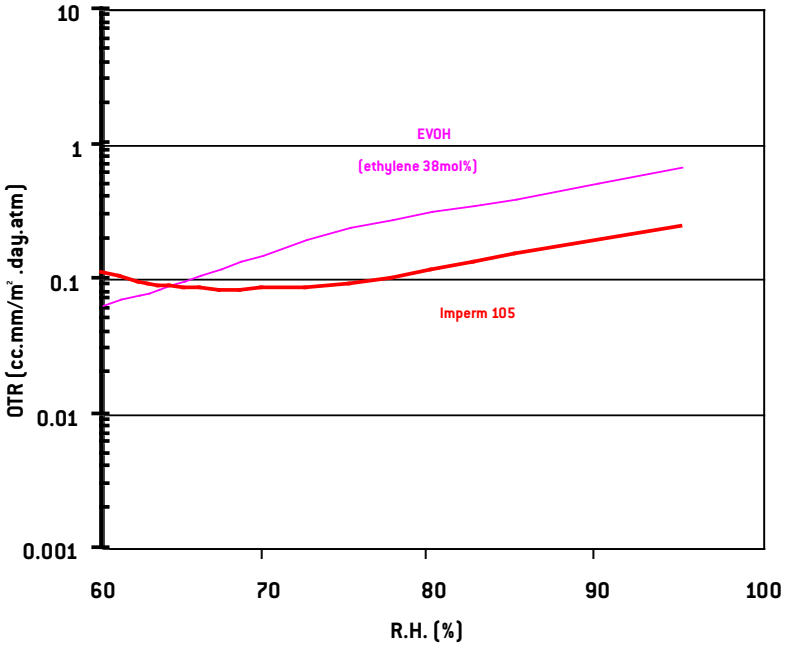
Gas barrier properties of non-oriented films

Item	Unit	Imperm 105	MXD6
OTR (23°C, 60%rh)	cc.mm/m².day.atm	0.02	0.09
CO2TR (23°C, 60%rh)	cc.mm/m².day.atm	0.11	0.30
WVTR (40°C, 90%rh)	g.mm/m².day	0.43	1.36

Temperature Performance

In addition to creating a tortuous path against gas permeation, nanoclay also acts as mechanical reinforcement within the Imperm structure. This reinforcing effect constrains the Brownian motion of Imperm's nylon molecules. The effect enhances relative barrier performance at elevated temperatures typical of transport and storage environments. Figure 4 compares barrier performance with EVOH at 35°C. Above 70% relative humidity, Imperm is twice as effective against oxygen transmission.

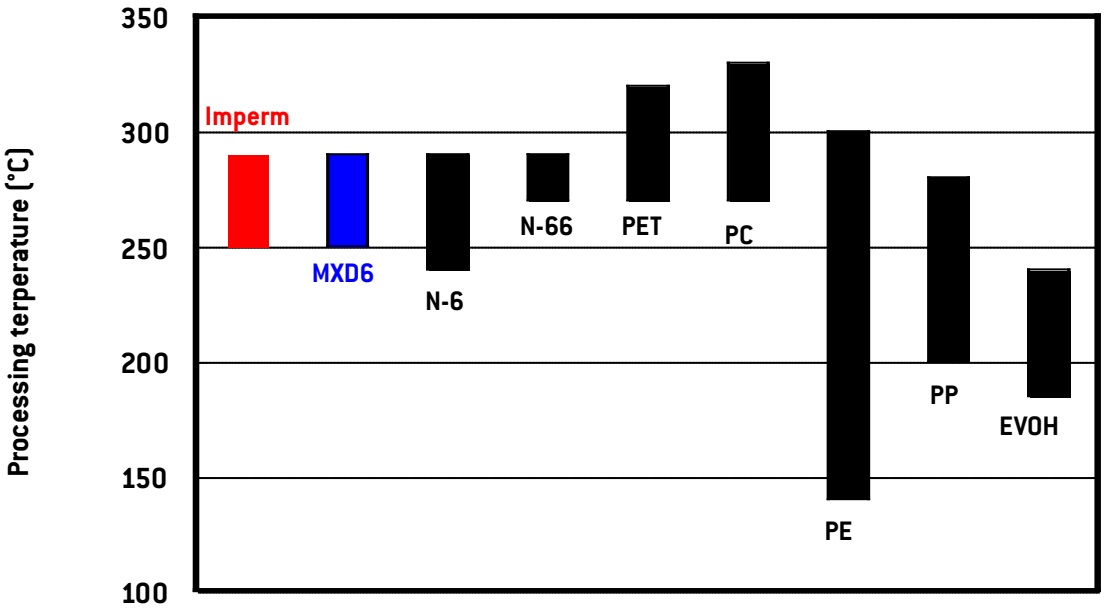
Figure 4
Oxygen barrier versus relative humidity
Non-oriented films@35°C

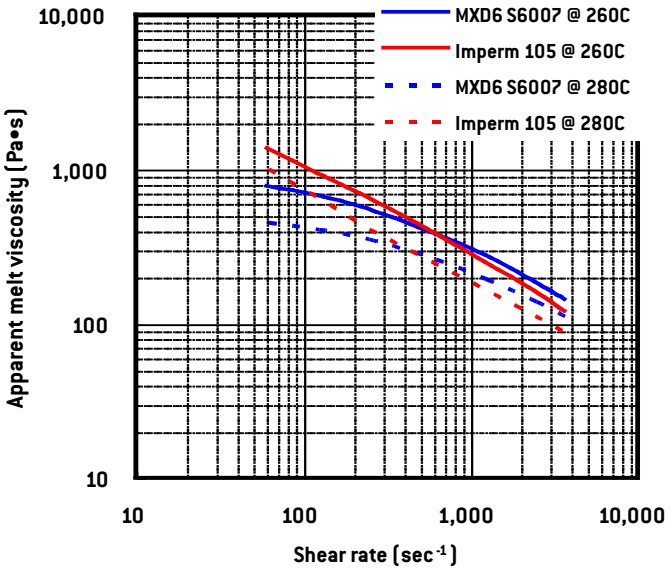


Imperm 105 can be processed under conditions similar to standard MXD6. The processing window ranges from 250-290°C, a good fit for polyethylene, polypropylene, nylon, PET, and others. The same holds true for melt rheology.

Figure 5

Processing temperatures of various resins





Multilayer films containing Imperm can be produced on typical co-extrusion equipment. Tables 3 and 4 provide co-extrusion conditions in combination with LLDPE and PET.

Table 3
Processing conditions for LLDPE/Imperm co-extrusion

Item	Unit	Imperm	LLDPE	Adhesive
Resin grade		105	2022L	M533
MFR	g/10min	--	2.1(190°C)	1.3 (190°C)
Relative viscosity		2.5	--	--
Extruder D	mm	40	45	30
Cylinder temp.				
C1	°C	235	160	190
C2	°C	265	170	200
C3	°C	265	180	210
C4	°C	--	190	--
C5	°C	--	200	--
head	°C	260	200	210
Feedblock temperature	°C		255-245	
T-die temperature	°C		240	
Chill roll temperature	°C		20	
Roll speed	m/min		5.5	
Film thickness	μm		100	
Film structure	μm		LLDPE/Imperm/LLDPE=40/20/40	
Oxygen transmission rate (23°C/60%RH)	cc/m²·day·atm	1.3		
Impact strength (23°C)	J	1.2		

2022L : Mitsui Petro. Chemical ULTZEX®
M533 : Mitsubishi Chemical Modic®

Table 4
Processing conditions for PET/Imperm co-extrusion

Item	Unit	Imperm	PET	Adhesive
Resin grade		105	RT543C	F543A
MFR	g/10min	--		3.5 (190°C)
Relative viscosity		2.5	--	--
Extruder D	mm	40	45	30
Cylinder temp.				
C1	°C	235	250	220
C2	°C	265	260	230
C3	°C	265	270	240
C4	°C	--	270	--
C5	°C	--	270	--
head	°C	260	270	240
Feedblock temperature	°C		270~260	
T-die temperature	°C		260	
Chill roll temperature	°C		70	
Roll speed	m/min		3.8	
Film thickness	μm		100	
Film structure	μm		PET/Imperm/PET=40/20/40	
Oxygen transmission rate (23°C/60%RH)	cc/m2·day·atm	0.12	--	--

RT543C : Japan UNIPET® IV=0.75 F543A : Mitsubishi Chemical Modic ®

Adhesive resins

Table 5 provides a list of adhesive resin suppliers. Typically, any adhesive resin used in conjunction with nylon 6 or EVOH is also suitable for Imperm.

Adhesive resins should be selected based on resin system, resin melt viscosity and processing techniques. Other factors, such as die design, may also have impact on adhesion performance. Our technical experts can assist you in choosing the optimum adhesive and processing conditions.

Table 5
Adhesive resins

Manufacturer	Adhesive Resin	Web Site
DuPont	Fusabond® Resin modifiers	http://www.dupont.com/industrial-polymers/plastics/selector/fuschart.html
Equistar Chemicals	PLEXAR® Tie-layer resins	http://www.equistarchem.com
Mitsui Chemicals	ADMER® Adhesive resins	http://www.mitsuichemicals.com/adm.htm
Mitsubishi Chemical	Modic®-AP Adhesive series	

Handling

As-shipped moisture is 0.1% so it is not necessary to dry pellets if you are using unopened bags. Vacuum drying is recommended for bags which have been open for greater than 2 hours. In this instance the pellets should be dried at 150°C, below 2 mmHg for 6-8 hours. Nitrogen purging is also recommended. If a hopper drier is used, the drying temperature should be reduced to 90°C for 10 hours to prevent yellowing.

Contact Information

NORTH & SOUTH AMERICA
ASIA

ColorMatrix Corporation
680 North Rocky River Drive
Berea, OH 44017

Website www.colormatrix.com
Telephone 216-622-0100
Fax 216-367-TIGR(8447)
Email info@colormatrix.com

EUROPE

ColorMatrix Europe Ltd
7-15 Unity Grove
Knowsley Business Park
Knowsley
Merseyside
L34 9GT
UK

Website www.colormatrix.com
Telephone +44-151-548-3100
Fax +44-151-548-3800
Email info@colormatrix.co.uk

NANOCOR, INC. 2870 Forbs Avenue, Hoffman Estates, IL 60192 www.nanocor.com
847.851.1918 847.851.1919 Tie Lan – tie.lan@nanocor .com