



## Solvents for Plastic Coatings

### Introduction

Plastic parts are used in a variety of applications including automobile and truck parts, business and office machines and household products such as televisions, window furnishings, appliances, personal care products and furniture. Coatings may be applied to improve the appearance of the product, protect the parts from physical or chemical stress, or reduce electromagnetic or radio-frequency interference.

Two types of coatings are typically used, solvent-based and waterborne coatings. Solvents historically used include toluene, methylene chloride and xylene. In addition to being volatile organic compounds (VOCs), these solvents are often classified as hazardous air pollutants (HAPs). A number of Dow Oxygenated Solvents, which are not classified as hazardous air pollutants, can function in these solvent-based plastic coatings.

### Challenges

Plastics represent one of the greatest challenges for coating manufacturers. The technology for coating on plastics is an extension of processes originally developed for metal and other non-polymeric substrates. Plastic substrates are unique in that they represent a multiplicity of surfaces each with its own adhesion characteristics and physical properties. As plastics are generally low-energy (non-polar or low surface tension) materials, wetting of the plastic substrate can be a challenge. Low surface tension solvents are important to achieve adhesion. Some solubility and interaction of the solvent with the plastic substrate is important. Solvents that exhibit some affinity for the resin can help diffuse the coating components into the surface of the substrate, providing improved adhesion.

Dow evaluated the effects of selected Dow Oxygenated Solvents, such as UCAR™ n-butyl propionate, UCAR n-pentyl propionate, UCAR n-propyl propionate, UCAR Ester EEP Solvent, glycol ethers, and diisobutyl ketone on various plastics, with the goal of promoting these solvents for applications in the formulation of plastic coatings in the United States and Asia. Several plastics were tested with various solvents to observe the interaction between them in a Surface and Immersion test. These solvents and resins are listed in Tables 1 and 2, respectively.

Table 1 – Solvents Analyzed

Solvent	Abbr.
mixed xylenes	XYL
n-butyl acetate	NBAC
n-propyl propionate	NPPT
n-butyl propionate	NBPT
n-pentyl propionate	NAPT
3-ethoxypropionic acid ethyl ester	EEP
n-butanol	n-BuOH
dipropylene glycol n-propyl ether	DPnP
dipropylene glycol n-butyl ether	DPnB
dipropylene glycol methyl ether	DPM
diisobutyl ketone	DIBK
methyl amyl ketone	MAK

Table 2 – Resins Analyzed

Plastic	Abbr.	Typical Uses
Propylene	TPO	Automotive painted fascia
Propylene (talc-filled)	TPO lf	Automotive instrument panels/trim
Acrylonitrile-Butadiene Styrene (high impact)	ABS hi	Appliances
Acrylonitrile-Butadiene Styrene (medium impact)	ABS mi	Automotive trim
Acrylonitrile-Butadiene Styrene (ignition resistant)	ABS ir	Electronics housings
Polycarbonate	PC	Headlamps, interior parts
Polycarbonate/Acrylonitrile-Butadiene Styrene (ignition resistant)	PC/ABS ir	Electronics housings
Polycarbonate/Polybutylene Teraphthalate	PC/PBT	Automotive bumpers
High-Impact Polystyrene	HIP #1	Containers
High-Impact Polystyrene	HIP #2	Appliances, housewares, toys
Polystyrene (ignition resistant)	PS ir	Portable electronics

## Surface Test

The solvent was dispensed onto the plastic substrate and covered with a 2" or 2.25" diameter Pyrex™ petri dish. After 24 hours, the cover was removed and each solvent was rated on a scale of 1-4, with 4 representing a significant attack; 3 representing light etching, minor swelling, dulling of surface and/or loss of gloss; and 2 representing some dulling of surface and/or loss of gloss; and 1 representing no observable effect. The results are depicted in Table 3 below.

Table 3 – Surface Test Results

	Aromatic		Esters				Alcohol	Glycol Ether			Ketones	
	XYL	nBAC	NPPT	NBPT	NAPT	EEP	nBuOH	DPnP	DPnB	DPM	DIBK	MAK
TPO	2	1	1	2	2	1	1	1	1	1	2	2
TPO (tf)	1	1	1	1	1	1	1	1	1	1	1	1
ABS (hi)	2	3	2	2	2	3	1	1	1	1	1	4
ABS (mi)	2	4	4	3	2	4	2	1	1	1	3	4
ABS (ir)	4	4	4	4	4	4	2	2	2	3	3	4
PC	4	4	4	4	4	4	1	1	1	1	2	4
PC/ ABS (ir)	4	4	4	4	4	4	1	1	1	2	2	4
PC/ PBT	2	2	2	2	2	2	1	1	1	2	2	2
HIP #1	3	3	3	3	3	3	1	2	1	1	3	3
HIP #2	4	4	4	4	4	4	1	2	2	4	2	4
PS (ir)	4	4	4	4	4	4	1	2	2	2	4	4
dynes/cm, 20°C)	27.6	25.3	24.7	25.3	26.4	28.1	24.8	27.8	28.4	28.8	23.2	26.1

## Immersion Test

A 1" x 1" square coupon of each plastic was placed into a bottle with a polyseal cap and immersed in each solvent. Each bottle was placed in a constant temperature water bath maintained at 50°C. After 24 hours the coupons were removed from the solvent, allowed to air dry for approximately two hours, and then weighed.

The table below (Table 4) is a combination of the Surface test results and the Immersion test results. The table shows solvents which rated a 2 or 3 for each plastic in the Surface test, which may be advantageous for improving coating adhesion. However, depending on the application, where the surface test may indicate a "good" solvent, the Immersion test results may differ.

Table 4 – Immersion Test Results for Solvents that Rated 2-3 in Surface Test

	TPO	ABS (hi)	ABS (mi)	ABS (ir)	PC	PC/ABS(ir)	PC/PBT	HIP #1	HIP #2	PS (ir)
XYL	forest	orange	orange				forest	orange		
NBAC		orange					forest	orange		
NPPT		orange					forest	orange		
NBPT	forest	orange	orange				forest	orange		
NAPT	forest	forest	orange				forest	orange		
EEP		orange					forest	orange		
n-BuOH			teal	teal						
DPnP				teal				forest	forest	forest
DPnB									orange	forest
DPM				teal		forest	teal			forest
DIBK	forest		teal	teal	teal	forest	teal	orange	orange	
MAK	forest						forest	orange		

**KEY**

- forest** Rated 2 or 3 in Surface test. Swell plastic substrate less than 5% in Immersion test
- green** Rated 2 or 3 in Surface test. Swell plastic substrate 5%-25% in Immersion test (excluding ABS ir and PS ir)
- teal** Rated 2 or 3 in Surface test. Swell plastic substrate 25%-50% in Immersion test
- orange** Rated 2 or 3 in Surface test. Swell plastic substrate greater than 50% in Immersion test
- yellow** Rated 2 or 3 in Surface test. Dissolved or partially dissolved plastic substrate in Immersion test. (could not recover plastic coupon)

Note: ABS (ir) and PS (ir) where not included in the Immersion test

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Published January 2006

