PROBLEM SOLVED

Commonly found in coatings and inkjet inks, solvents vary in their ability to dissolve solutes and how safe they are to use. Kouji Nakajima looks at a reduced-toxicity amide-ether option

Having high heat resistance, Polyamide-imides (PAI) and polyimides (PI) are widely used as insulating varnish materials in the application to the coils of electronic devices and high performance coatings – this market is expected to be continuously high growth with the spread of electric vehicles etc. However, PAI and PI are poorly-soluble polymers, making them difficult to dissolve completely using solvents. Typically, non-ionic polar solvents such as N-Methyl pyrrolidone (NMP) and Dimethyl formamide (DMF) have been used to tackle this issue, but due to the safety concerns such as reproductive toxicity, various alternative solvents have been looked into.

Producer of synthetic resins, industrial chemicals and related products, KJ Chemicals Corporation has launched two amide-ether type solvents with high dissolving power that offer an alternative to and can replace N-Methyl pyrrolidone (NMP) and Dimethyl formamide (DMF) on the global solvent market.

Another Japanese company, Idemitsu Kosan Co., Ltd, which handles energy related business, explored using an amide ether solvent (former name: Equamide) candidate for NMP replacement in the past, and started marketing it in recent years.

KJ Chemicals believes it has made technical improvements to this with its own product:

KJCMPA-100 AND KJCBPA-100

KJ Chemicals has produced its own line-up of two highly soluble amide ether solvents: 3-Methoxy-N, N-dimethylpropanamide (KJCMPA-100) and 3-Butoxy-N, N-dimethylpropanamide (KJCBPA-100). The solvents are highly amphipathic [having both hydrophilic (mixes/dissolves with water) and hydrophobic (water-repelling) properties]; in particular, KJCBPA-100 can be mixed completely into water and oils at any ratio.

"KJCBPA-100 can be mixed completely into water and oils at any ratio"

The table below shows Hansen solubility parameters for several non-ionic polar solvents. KJCMPA-100 shows values close to NMP and DMF, while KJCBPA-100 shows the values relatively close to Tetrahydrofuran (THF), which is used as the synthetic solvent for the pharmaceuticals and the agricultural chemicals.

Solvents	δD	δP	δH	$\delta(J/cm^3)^{1}/_{2}$
KJCMPA-100	17.2	10.9	9.5	22.5
KJCBPATM-100	16.9	6.4	6.8	19.3
NMP	18.1	10.3	6.6	21.8
DMF	17.0	13.3	10.9	24.2
THF	16.7	4.9	5.5	18.3

(Seiko PMC, 24th National Symposium on Polymer Analysis and Characterisation; 24–25 October 2019, Tsukuba, Japan)

APPLICATIONS

KJCMPA-100 and KJCBPA-100 can be used in the synthesis of [substance] such as PAI, PI, Nylon and Polyurethane resin (PUR); for adjusting the viscosity for the inkjet inks; for improving the dispersion stability of water-based paints; and for manufacturing process applications for pharmaceuticals and agrochemicals.

KJ Chemicals' solvents have a low contact angle and the wettability to the PC substrate is about twice as high as that of NMP (see chart below showing contact angles on different substrates). The solvents enhance the spray stability of printing machineries and can be expected to improve printability on PC and PVC substrates when using the inkjet inks.

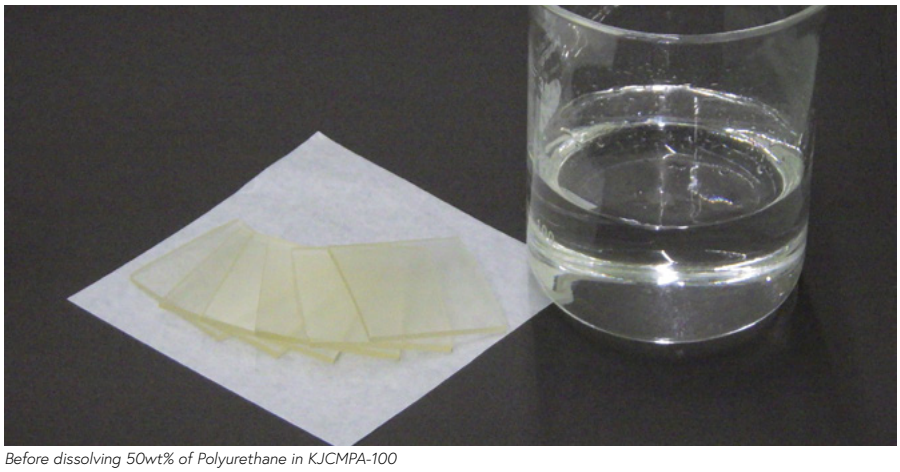
	Substrates		
Solvents	PC	PVC	Glass
KJCMPA®-100	10.8°	14.7°	11.1°
KJCBPATM-100	8.3°	13.2°	17.5°
NMP	20.2°	20.7°	15.2°

MARKETING IN EUROPE

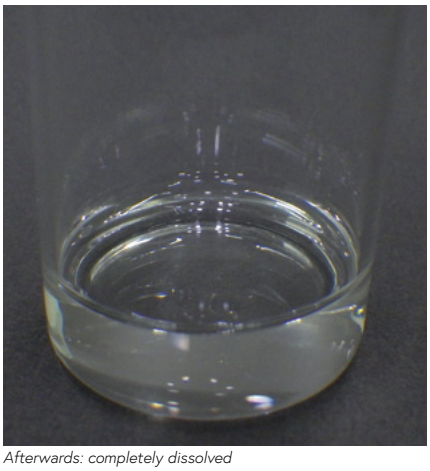
NMP and DMF are listed on the restricted substances list (Entry 71[1], Entry 72[2]) of REACH [Registration, Evaluation, Authorisation and Restriction of Chemicals] Annex XVII due to concern about the reproductive toxicity, and their handlings are currently restricted in Europe. Regarding the reproductive toxicity of KJCMPA-100, several kinds of studies such as the prenatal developmental toxicity study (OECD No.414) were carried out and it was

"The solvents can be expected to improve printability on PC and PVC substrates"

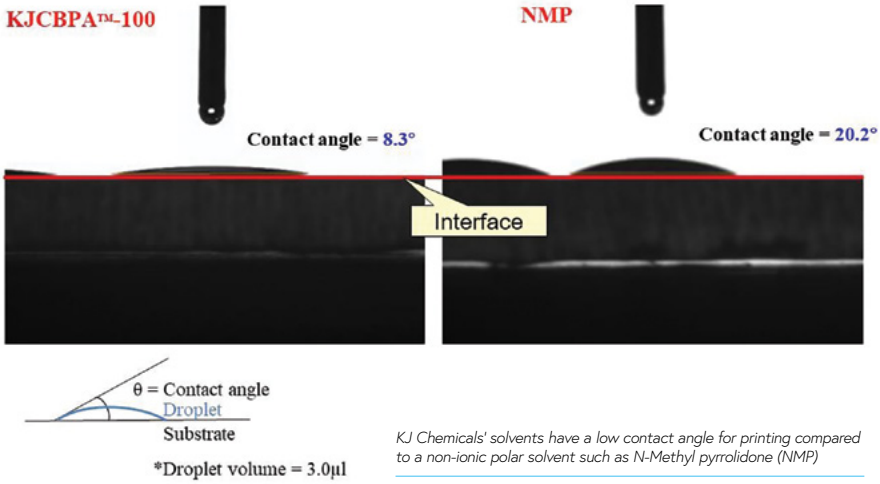
confirmed that this solvent does not show the reproductive toxicity like a teratogenicity [the ability to cause developmental anomalies in a foetus]. Compared to NMP, KJCMPA-100 and KJCBPA-100 are solvents with high safety and low skin irritation, and therefore not subjected to such regulations. KJCMPA-100 is registered



Before dissolving 50wt% of Polyurethane in KJCMPA-100



Afterwards: completely dissolved



KJ Chemicals' solvents have a low contact angle for printing compared to a non-ionic polar solvent such as N-Methyl pyrrolidone (NMP)

in the chemical inventory in major countries; KJCBPA-100 will also meet the regulations of each country depending on the needs of the future market. Alphechem[3], an Italian consulting firm, was appointed to introduce this product to a European chemical maker and is currently engaged in that activity. ■

Footnotes: KJCMPA-100 is a registered trademark of KJ Chemicals Corporation
[1]https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018R0588
[2]https://eurlex.europa.eu/legalcontent/EN/TXT/?uri=uriserv:OJ.L_.2018.256.01.0001.01.ENG&toc=OJ:L:2018:256:TOC
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