

## Urethane-acrylic Hybrid Dispersions

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### Introduction

Environmental legislation to lower, or eliminate, VOC emissions is causing the surface coatings industry to switch from solvent-borne to water-borne technologies. Current coatings still use solvents, such as N-methyl pyrrolidone (NMP), to regulate viscosity. However, some NMP remains in the final dispersion. Urethane-acrylic co-polymerisation is an alternative route to overcome this NMP emission problem<sup>1, 2</sup>. Composite particles made by this route can yield films which exhibit very attractive properties such as increased hardness, toughness, abrasion resistance and flexibility<sup>3</sup>.

### Experimental

Two synthesis routes were employed to prepare urethane (U) – acrylic (A) particles at a 50:50 weight ratio.

**Route 1:** Polyurethane prepolymers were synthesised from isophorone diisocyanate, polypropylene glycol, dimethylol propionic acid and neutralized with triethylamine in the presence of 20 wt% of either a MMA-BA or a S-BA mixture. The polyurethane prepolymers were then dispersed in water and chain extended with hydrazine and then the acrylic/styrene monomers were polymerised. Later these hybrid particles were swollen with a further 30wt% of the same monomer mixture for 60 minutes before it too was polymerised. The samples are coded U/A1<sub>M</sub> and U/A1<sub>S</sub>.

**Route 2:** Here, the same aqueous polyurethane dispersion was made without any acrylate/styrene monomers being present. Then, it was swollen for 60 minutes with the 50 wt% monomer charge which was then polymerised. These samples are coded U/A2<sub>M</sub> and U/A2<sub>S</sub>.

**Control Samples:** The same polyurethane aqueous dispersions, with 20 wt% of NMP, were synthesised. Later, the acrylic/styrene monomers were added at 50 wt%, as in route 2. The samples are coded U/A3<sub>M</sub> and U/A3<sub>S</sub>.

The cast films were characterised using stress-strain tests, dynamic mechanical thermal analysis and transmission electron microscopy.

### Results

Table 1 shows the stress-strain results and figure 1 the tan  $\delta$  versus temperature data for all samples.

Table 1: The stress-strain data

Sample	Composition	Stress (MPa)	Elongation (%)
U/A1 <sub>M</sub> (Route 1)	50:50 PU:MMA/n-BA (MMA/n-BA as reactive diluent)	14	715
U/A1 <sub>S</sub> (Route 1)	50:50 PU:Styrene/n-BA (styrene/n-BA as reactive diluent)	15	1240
U/A2 <sub>M</sub> (Route 2)	50:50 PU:MMA/n-BA (no reactive diluent)	15	475
U/A2 <sub>S</sub> (Route 2)	50:50 PU:MMA/n-BA (no reactive diluent)	15	625
U/A3 <sub>M</sub> (Control)	50:50 PU:MMA/n-BA (20wt% NMP)	1.8	741
U/A3 <sub>S</sub> (Control)	50:50 PU:MMA/n-BA (20wt % NMP)	1.1	1343

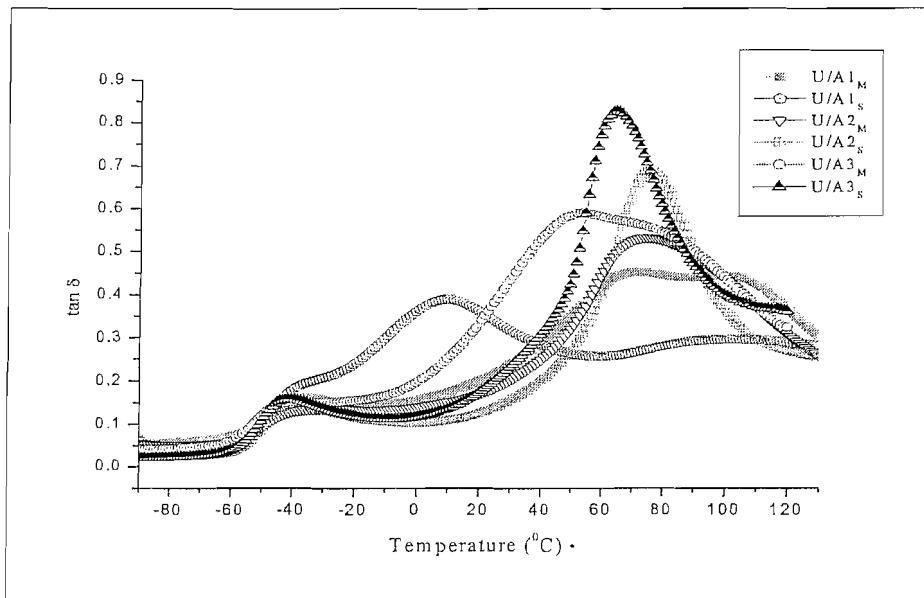


Figure 1: Tan  $\delta$  versus temperature data.

All the NMP-free samples exhibited much higher tensile strengths than the NMP-containing material because of the plasticizing ability of NMP arising from its retention in the dried film. Route 1 and the NMP samples showed higher ultimate elongations than route 2 materials. All styrene-based samples showed higher ultimate elongations than MMA-based samples.

The DMTA data show very clear differences between the various synthesis methods, which means this approach offers a powerful way to engineer morphologies which lead to valuable film properties.

## References

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