# Advantages of Omicure U-52 as an Accelerator for Dicy Cured Epoxy Resin Systems

**Omicure U-52** is an aromatic substituted urea designed for use as a latent accelerator in one part, dicyandiamide (dicy) cured, epoxy formulations. Dicy will work, on its own, as a curing agent for epoxies, showing good latency and cured physical properties that are acceptable for many applications. However, cure temperatures in excess of 170°C are generally required in order to provide effective cure time and properties. Substituted ureas are commonly used to accelerate the dicy/epoxy reaction, help provide cure in a timely fashion at lower temperatures, while still providing good latency of one-part systems. When compared to other more common substituted ureas, **Omicure U-52** shows an outstanding combination of performance properties such as latency, time to full cure, and glass transition temperature.

The thermal analysis and RT viscosity stability graph below shows results of a study comparing the properties of **Omicure U-52** [4,4'-Methylene bis (Phenyl Dimethyl Urea] and two more popular and commonly used substituted ureas, Omicure U-405 (Phenyl Dimethyl Urea) and Diuron [3-(3,4-Dichlorophenyl)-1,1- Dimethyl Urea] against a non-accelerated control. The substituted urea accelerators were compared at use levels of 1, 3, and 5 parts by weight (pbw) per hundred parts resin in a one part adhesive blend consisting of 100 parts by weight of DGEBPA, 8 parts Dicy, and 3 parts fumed silica.

Each system was tested for initial viscosity at room temperature, and every four weeks thereafter to determine the relative useable shelf life of each. The useable shelf life was established as the time taken for a two-fold increase in viscosity to occur vs. initial. The results indicate the **Omicure U-52** containing products had shelf lives at least twice as long as formulations accelerated with the other two substituted ureas.

Thermal analysis was run on each sample using DSC. Peak exotherm, glass transition temperature ($T_g$), and time to 95% full cure were run.

The data on peak exotherm (Exhibit A) shows that the **Omicure U-52** systems had exotherms that were lower than the unmodified control as well as the other corresponding substituted urea containing mixtures. This is important because lower exotherm will help reduce cure shrinkage, warpage, and stress in cured product.

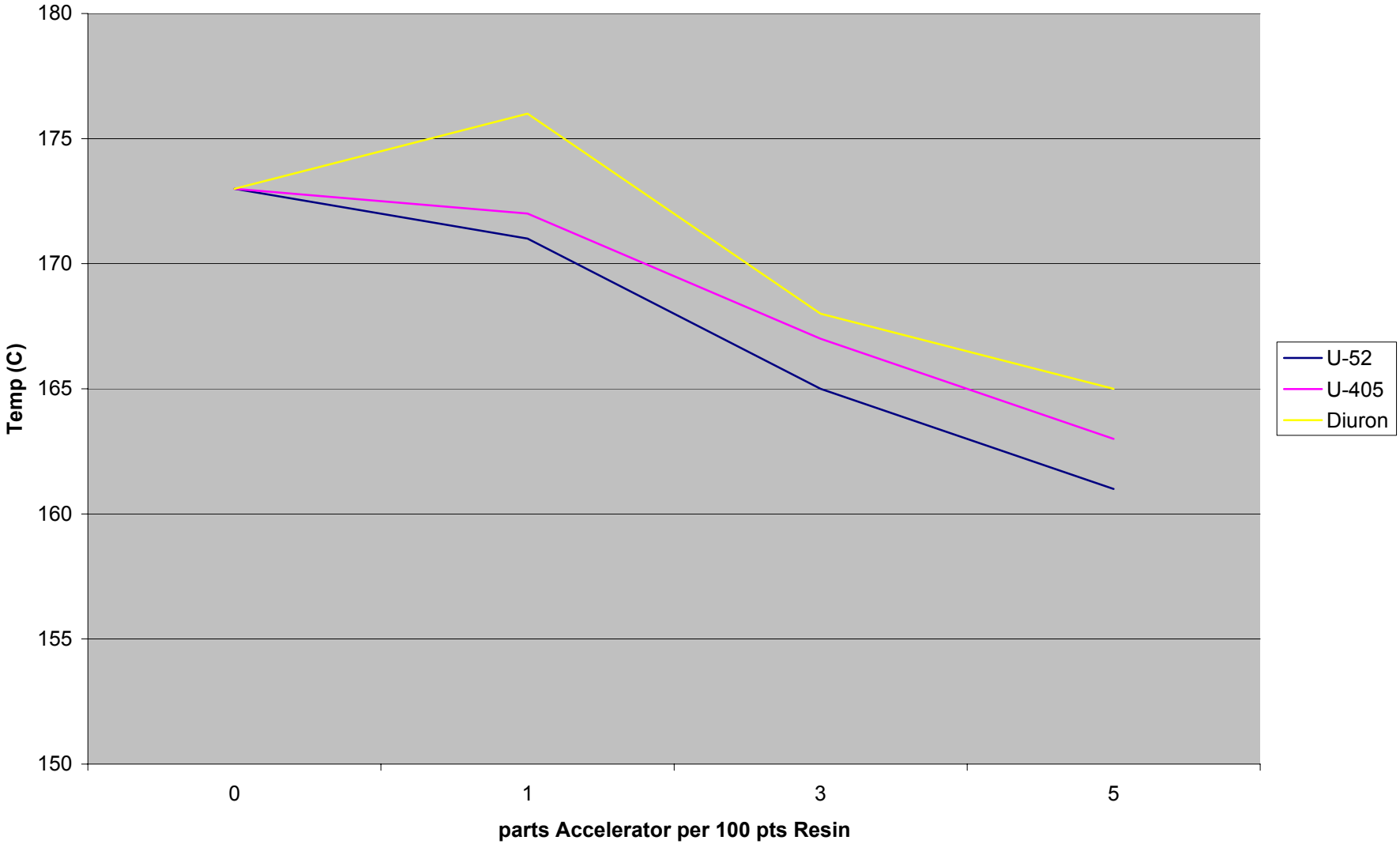
Glass transition temperatures (Exhibit B) generally decrease with addition of substituted urea. While all of the substituted ureas in this study follow that trend, the data shows that the **Omicure U-52** has the least effect on $T_g$ depression. This allows U-52 accelerated systems to be used at higher temperatures than those accelerated with the other substituted ureas.

With increased latency, longer times to full cure at any given temperature would be expected. This trend does not hold true in this experiment. The results of analysis run to determine the time for each system to achieve 95% full cure indicate the **Omicure U-52** is equal to or better than the Diuron accelerated systems and only slightly slower than the Phenyl Dimethyl Urea systems. (Exhibit C) The data indicates that of the three ureas compared, the Omicure U- 52 shows the longest latency, lowest exotherms, and highest Glass Transition temperatures, while still providing satisfactory times to achieve full cure at 120°C.

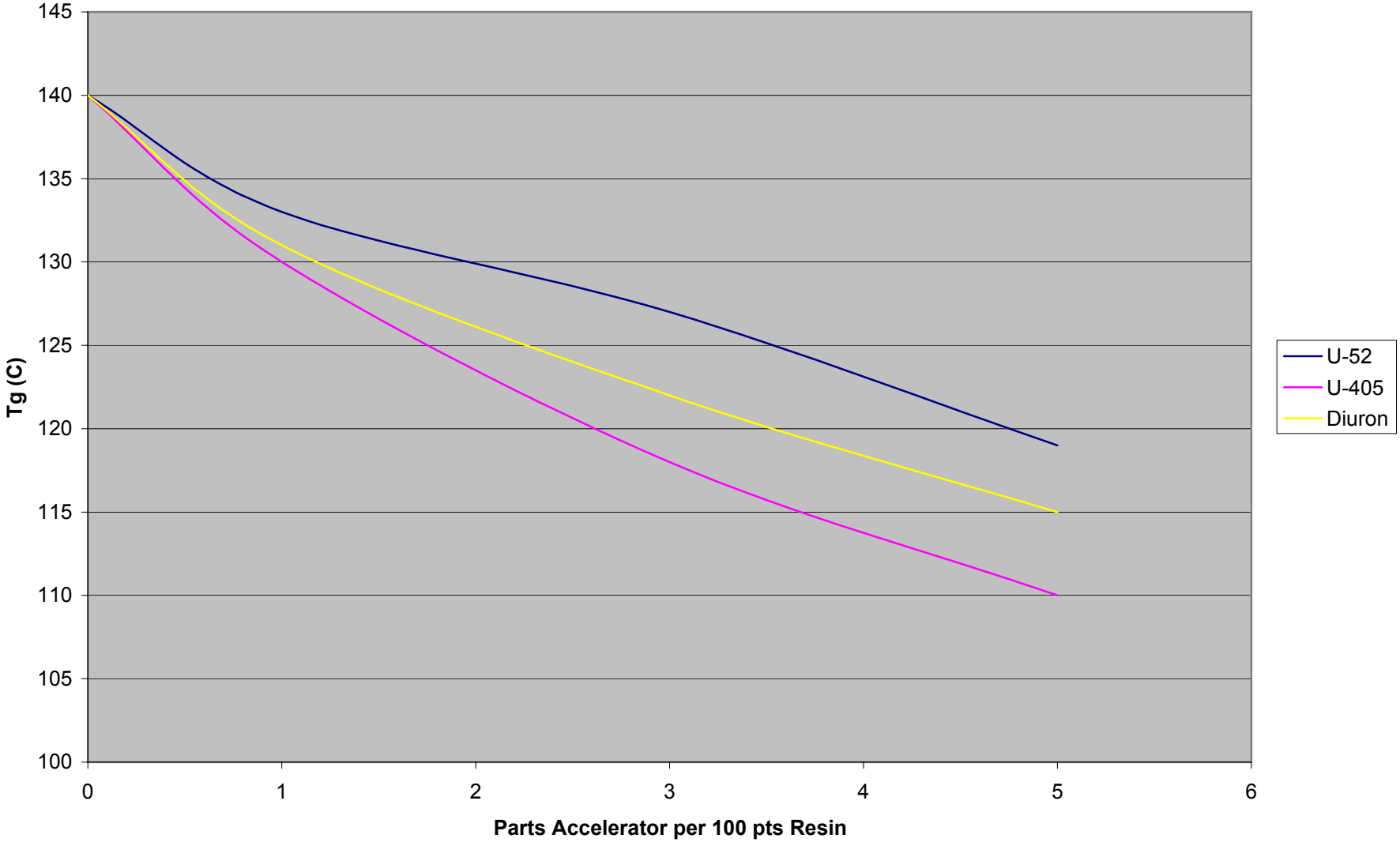
Thermal Analysis and RT viscosity stability of DGEBPA/Dicy/fumed silica (100/8/3 pbw) accelerated with substituted ureas

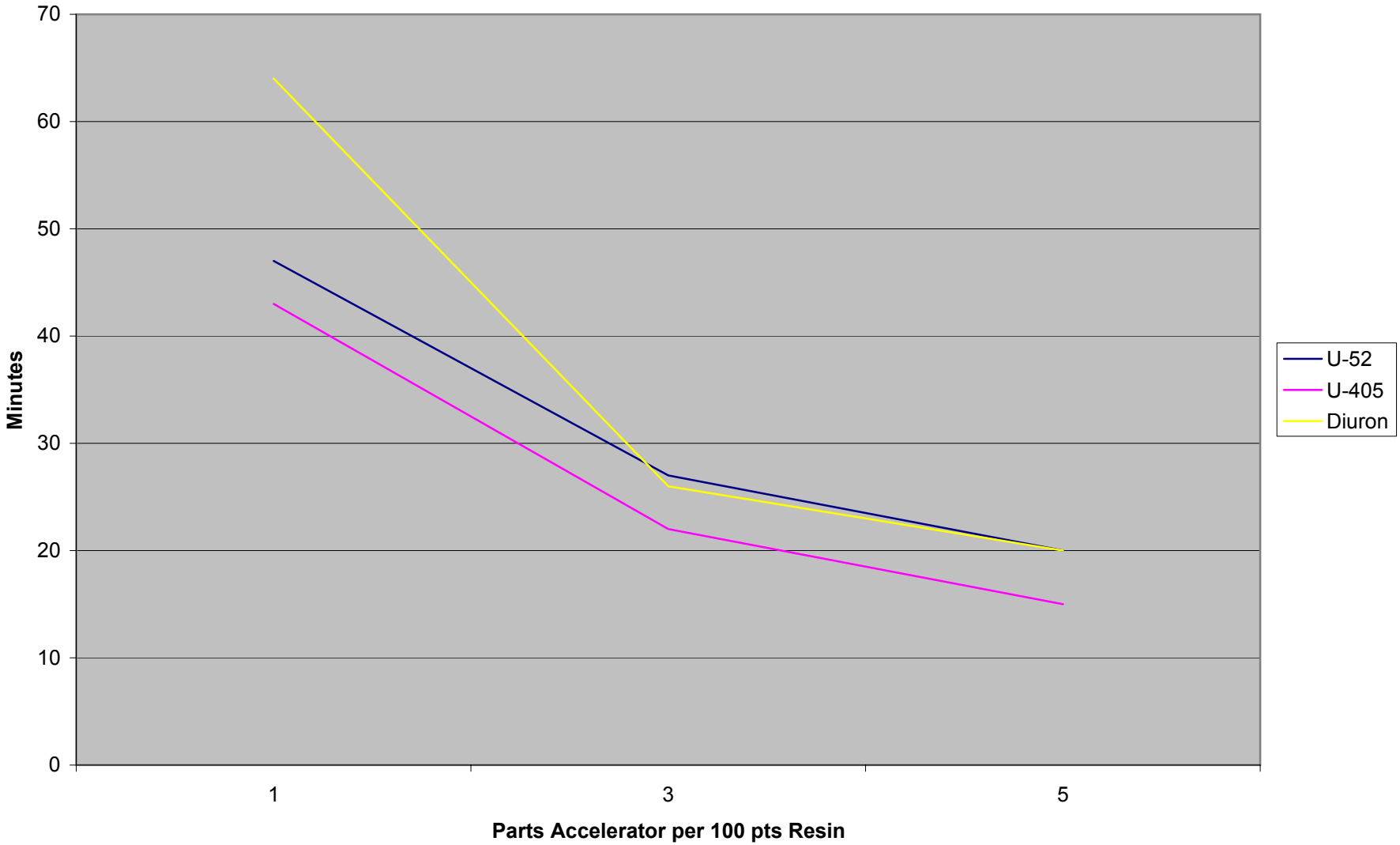
| | Control | 0 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | U-52 | | 1 | 3 | 5 | | | | | | |
| | U-405 | | | | | 1 | 3 | 5 | | | |
| | Diuron | | | | | | | | 1 | 3 | 5 |
| | | | | | | | | | | | |
| Viscosity @ 25C (poise) | Initial | 290 | 370 | 390 | 420 | 310 | 320 | 320 | 320 | 350 | 360 |
| | 1 week | 300 | 360 | 390 | 420 | 320 | 320 | 320 | 320 | 330 | 350 |
| | 4 week | 290 | 350 | 380 | 410 | 330 | 340 | 350 | 330 | 360 | 370 |
| | 8 week | 300 | 410 | 440 | 470 | 340 | 440 | 480 | 350 | 380 | 400 |
| | 12 week | 310 | 360 | 400 | 430 | 370 | 1900 | 2140 | 390 | 430 | 460 |
| | 16 week | 320 | 370 | 410 | 450 | 480 | - | - | 430 | 480 | 520 |
| | 20 week | 320 | 400 | 450 | 490 | 630 | - | - | 450 | 560 | 590 |
| | 24 week | 300 | 400 | 450 | 470 | 970 | - | - | 470 | 660 | 730 |
| | 28 week | 330 | 440 | 490 | 530 | 3000 | - | - | 560 | 1000 | 1400 |
| | 32 week | 350 | 440 | 500 | 540 | - | - | - | 760 | - | - |
| | 36 week | - | 460 | 530 | 590 | - | - | - | 1000 | - | - |
| | 40 week | 320 | 470 | 550 | 620 | - | - | - | - | - | - |
| | 44 week | 350 | 490 | 580 | 660 | - | - | - | - | - | - |
| | 48 week | 330 | 540 | 650 | 740 | - | - | - | - | - | - |
| | 52 week | 340 | 580 | 710 | 770 | - | - | - | - | - | - |
| | | | | | | | | | | | |
| Time to double viscosity (weeks) | | >136 | 60 | 55 | 57 | 20 | 10 | 9 | 30 | 25 | 24 |
| | | | | | | | | | | | |
| Thermal Analysis | Peak Exotherm (deg. C) | 173 | 171 | 165 | 161 | 172 | 167 | 163 | 176 | 168 | 165 |
| | minutes to 95% cure at 120C | - | 47 | 27 | 20 | 43 | 22 | 15 | 64 | 26 | 20 |
| | Tg (deg. C) | 140 | 133 | 127 | 119 | 130 | 118 | 110 | 131 | 122 | 115 |

## Peak Exotherm Comparison (Exhibit A)



## Glass Transition Temperature (Exhibit B)




Minutes to 95% Full Cure @ 120C(Exhibit C)
70
60
50
40
30
20
10
0
Minutes
1
3
5
Parts Accelerator per 100 pts Resin
U-52
U-405
Diuron