Water–Dilutable Urethane Acrylate UV–Curing Technology

In most coating applications, there is a need to clean equipment of uncured product. In 3D printing the parts need to have uncured resin removed before post curing or use. Typically, 100% UV systems do not wash away with water and require harsh solvents that can damage 3D models or rubber seals. Solvents used in the washing of materials in printing press and 3D printing applications include aggressive solvents like isopropyl alcohol (IPA), methyl ethyl ketone (MEK), and acetone. These solvents can invoke regulations depending on their VOC status and volumes used. The use of water as a solvent is more ideal because it is not flammable and not a VOC. To create a standard UV formula that is dilutable in water, primary materials used must be hydrophilic. Examples of hydrophilic materials used today are polyethylene glycol diacrylate, 2–(2–ethoxyethoxy) ethyl acrylate (EOEOEA), acryloyl morpholine (ACMO), or any other ethoxylated–longer chain length monomers. While other water–soluble UV monomers are able to create solvency with exposure to water in formulas, they can also degrade or negatively impact physical properties due to the hydrolysis of the hydrophilic moieties. Materials that can be used to improve solvency of UV resins in water while maintaining their properties after exposure to water are of interest in a variety of applications.

XR–9416 as an Emulsifying Additive for Water–Washable Resins

New trends in 3D printing prefer water–washable resins to those that require isopropyl alcohol (IPA). XR–9416 can be used as an additive in a non–water washable system to make it water washable. Figure 1 uses a hydrophobic (non–water washable) model 3D printing formulation to display the effects of increasing levels of XR–9416 in a non– water dilutable environment. By adding increasing percentages of XR–9416 to the rigid formula, it becomes water–dispersible and interfacial tension drops dramatically. Concentration needed to make a formula water washable will depend on the base formulation. Therefore, Figure 1 does not represent all situations but instead aims to give an idea of the XR–9416 performance in a non–water–washable setting. XR–9416 will also have an impact on the physical properties of a formulation, for example, adding 20–30% levels of XR–9416 to a soft formula will increase hardness, so the formula amounts may have to be adjusted.

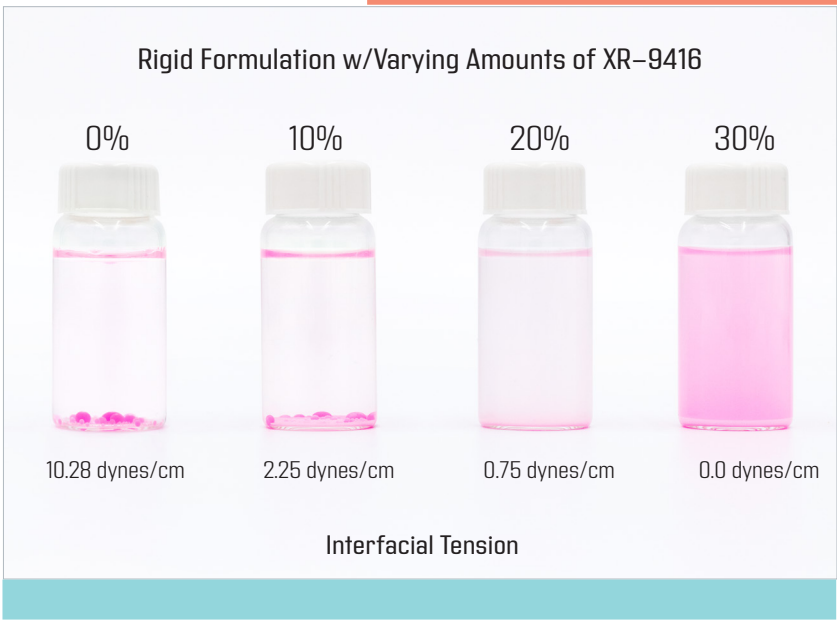


Figure 1. Rigid Formulation from 3D Printing Technology Bulletin with Increasing levels of XR–9416 to Improve Water Washability

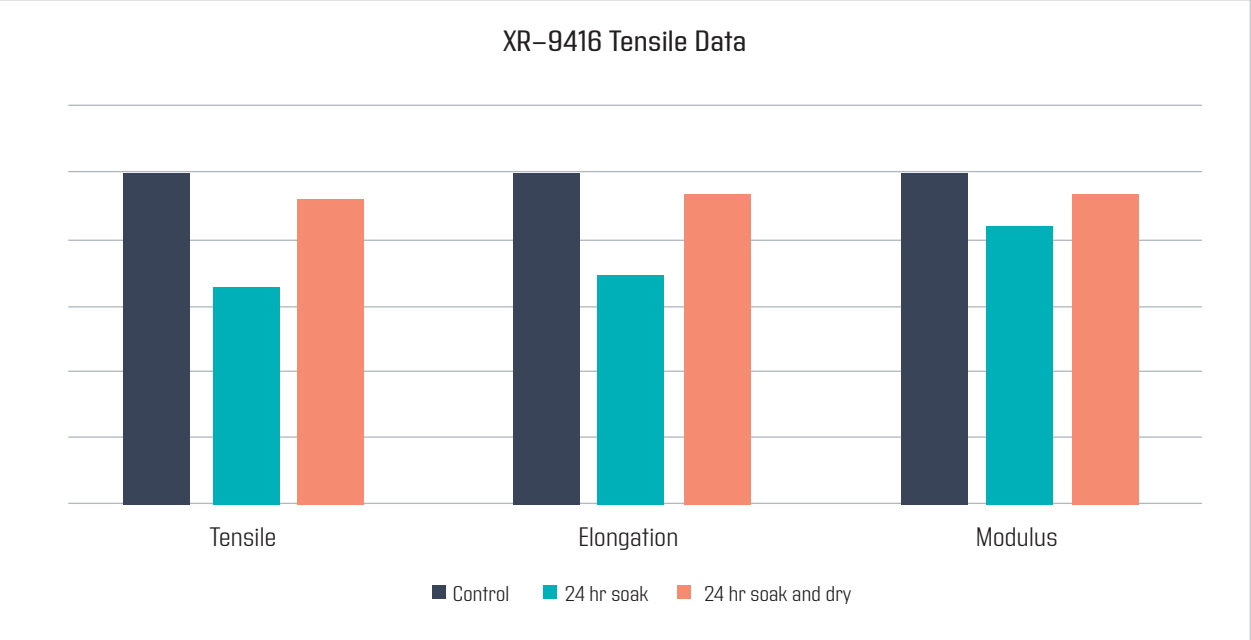
XR–9416 as a Surfactant Oligomer for Waterborne UV Formulations

XR–9416 is an oligomer with hydrophobic and hydrophilic regions that allow it to emulsify or act as a surfactant in standard UV formulas. XR–9416 can also be used in water–reducible UV inks and coatings. Since it improves compatibility of hydrophobic resins with water, it is possible to develop a UV curable ink with desirable properties that can be reduced in viscosity with water for various applications. By adding water to a low gloss system with XR–9416, more efficient use of matting agent may be obtained. Anywhere where a drying step is tolerable or desirable, XR–9416 can add formulation flexibility. In addition, these systems also offer the following desired benefits:

- saving on production, energy, and shipping costs;
- superior weathering, chemical, and solvent resistance;
- the substitution of water for solvents helps the environment by significantly reducing VOCs (Volatile Organic Compounds).

Oligomer	% Solids	Functionality	50:50 oligomer & IBOA with 2% Omnirad™ 481				
			Uncured Solution Viscosity, cP @ 25°C	Cured Mechanical Properties			Cured Durometer Hardness
				Tensile Strength, psi	Elongation, %	Elastic Modulus, ksi	
XR-9416	100	3	140	5,700	2.7	273	84D

To test the properties and water washability of XR–9416, tensile strips were prepared and then tested under varying conditions. The highest tensile, elongation, and modulus are produced by the samples submerged in water for 24 hours and dried in a 60°C oven for 2 hours. While other hydrophobic materials used for water–washable resins will degrade upon exposure to water, XR–9416 will retain 92% of mechanical properties upon cycling exposure to water.



Bomar XR–9416 oligomer is available for sampling now.
Custom water–dilutable oligomers and coatings are created upon request.

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