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BETTER PARTICLE SIZE SOLUTIONS

APPLICATION NOTE

Using BeNano 90 Zeta to measure the particle size and zeta potential of multicolor UV-sensitive resins

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Introduction

Multicolor UV-sensitive resins are dispersions where organic or inorganic particles are suspended in liquid photopolymers. They are widely used in the fields of 3D printing, inks, and paintings. As the increase of the requirements for the appearance and performance of the products, the size of the added particles tends to become smaller and smaller. When the particle size is down to the nanoscale, many properties of the resin, such as the dispersibility of the particles, curing properties, glossiness, and brightness, will be improved greatly.

However, the actual dispersion state of nanoparticles in resin is not always at the nanoscale as we expect. Nanoparticles always tend to aggregate due to their high surface energy and low wetting ability with resins. How can researchers improve the dispersibility and keep them dispersing stable is very important to the actual application.

In this application note, we used the BeNano 90 Zeta nanoparticle size and zeta potential analyzer to measure the particle size distribution and zeta potential of UV-sensitive resins added with different nanoscale pigments, investigating their dispersibility and stability.

Particle size distribution

BeNano 90 Zeta adopts dynamic light scattering (DLS) technology for nanoparticle size. A light source with a wavelength of 671nm illuminates the sample where particles undergo random walk, and the scattered light will be collected by the APD set at 90°, and the software calculates the particle size by the Stokes-Einstein equation.

$$D = \frac{k_B T}{3\pi D_H}$$

In this case study, we measured 6 nanoscale samples shown in the picture. One of the white samples came from brand B, others were from brand A. All of the raw liquid was diluted 10,000 times with ethyl acetate. The necessary parameters for the measurement are the refractive index and the viscosity of ethyl acetate, 1.37 and 0.426cp at 25°C, respectively. Each sample was measured 6 times to calculate the average size and standard deviation.

6 UV-sensitive resins

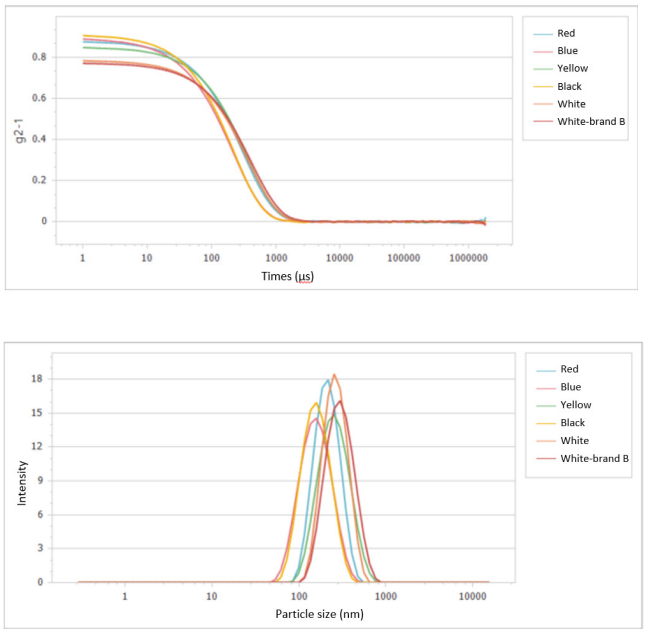


Figure 1. The correlation curves of the samples (a) and the particle size distributions (b)

By DLS, we got the PSDs of the 6 samples in Figure 1. As we can see, the distribution of every sample shows unimodal characteristics without aggregates.

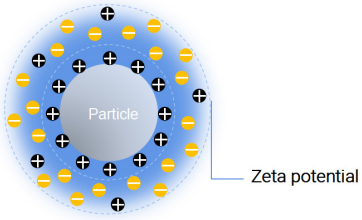
Table 1. The average particle size of 6 repetitive tests and the polydispersity index (PD.I)

	Particle size (nm)	PD.I
Red	201.34±1.06	0.16
Blue	144.66±1.16	0.19
Yellow	237.10±1.06	0.122
Black	148.52±1.08	0.115
White	256.09±1.74	0.088
White – brand B	279.29±2.31	0.127

Table 1. shows that all of the pigments used in the resins are at nanoscale within 100~300nm, and the standard deviations are small, which manifests that particles are dispersed evenly. The PD.I of each sample is over 0.08, which means that the particle size has a certain distribution. Compared to the white sample from brand B, the one from brand A has a smaller particle size, PD.I and standard deviation.

Zeta potential

Zeta potential is a parameter that characterizes the potential at the shear plane of the particles dispersed in a liquid. It is strongly impacted by the charge density of the particle surface and the liquid environment. Measuring the zeta potential can obtain surface charge and stability information of the sample.



Using BeNano 90 Zeta, we measured the zeta potential of the white resin (brand A) diluted by ethanol. With the electrophoretic light scattering (ELS) technology, the instrument measures the Doppler frequency shift of the scattered light caused by the electrophoretic movements of charged particles in an electric field and calculates the zeta potential by Henry's equation.

$$\mu = \frac{2\varepsilon_r \varepsilon_0 \zeta}{3\eta} f(\kappa\alpha)$$

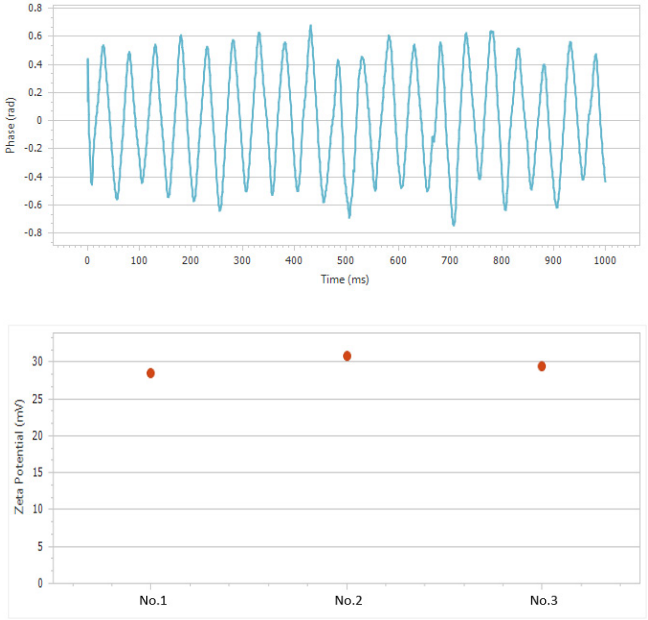


Figure 2. The phase plot of the 1st measurement (a) and zeta potentials (b) of diluted white UV-sensitive resin.

Figure 2 shows a high-quality phase plot in which the phase scales linearly with time, indicating that the particles have strong electrophoretic movements. The under coulomb forces measurement was repeated 3 times, and the zeta potentials were all close to 30 mV, which indicated that the pigment particles carried positive charges, and it was high enough to keep them stable from aggregating.

Conclusion

BeNano 90 Zeta is a reliable tool possessing high resolution and stability for measuring nanoparticle size and zeta potential of particles in UV-sensitive resin. It is helpful to researchers and developers to improve the formulation and evaluate the stability of the products.

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