Microsphere adhesives: New performance and applications

By Mike Witte, director of national accounts - polymer, Franklin Adhesives & Polymers

Abstract

Basic microsphere-adhesive technology has been around since the late 1960s. Yet, coaters and converters have only begun to touch the possibilities of microspheres – the most repositionable pressure-sensitive adhesives (PSAs) available. At the same time, recent advancements in microsphere technology have expanded uses for these materials. For example, current microsphere technology varies the size of the particles (or spheres) that give microspheres their high repositionability. Different sphere sizes alter the degree of tackiness, or repositionability, enabling microspheres to adhere to a wider variety of substrates and surfaces, such as paper, wood, metal, painted surfaces, refrigerators and walls. Microsphere adhesives also can be customized to specific applications. Converters and coaters can dial in the ideal performance characteristics. Such customization opens new possibilities for the development of unusual solutions for labels, tapes, packaging, etc.

Microsphere basics

Microsphere adhesives are the most repositionable type of pressure-sensitive adhesives (PSAs) available for labels, tapes and packaging. They can be lifted and reaffixed repeatedly, without affecting the face stock or the substrate. In contrast, although removable PSAs are easily peeled from a substrate, they are not intended for continual re-adherence. Permanent PSAs are designed to remain affixed to the substrate, and removal typically results in damage to the label and residual adhesive on the substrate.

Microspheres represent a significant advancement in PSA technology. Yet, they are based on a simple concept — the use of larger particles (see Figure 1). Although microscopic and measuring between only 10 and 250 microns, the particles (or spheres) used in microsphere adhesives are much larger than the emulsion particles found in conventional PSAs. These spheres form a discontinuous adhesive surface, which limits physical contact with the substrate, resulting in low peel and stable tack over time. The adhesives hold face stock firmly in place on most substrates, but are easily removable and permanently repositionable. Conversely, the smaller emulsion particles used in other PSAs coalesce into a continuous film that is not repositionable.

Bowling Balls and BBs

Sphere size relative to binder particle size

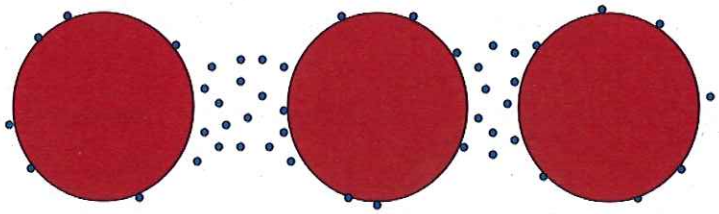

FIGURE 1. *Bowling Balls & BBs: The relationship between spheres and emulsion particles in microspheres. This diagram shows what microsphere adhesive looks like coated onto paper. The bowling balls (the red circles) represent the spheres, and the BBs (the black dots) represent the emulsion or binder particles used in conventional PSAs. Only the larger spheres make contact with the substrate, so this diagram represents a small amount of adhesive. The amount of BBs in the adhesive determines stickiness and makes it repositionable. Different bowling balls come into play each time the coated paper is affixed to a specific substrate. This is because each substrate has a distinctive texture, causing different balls to come into contact with it. The adhesive requires sufficient BBs to ensure the proper stickiness for a particular substrate. The amount of liquid containing both types of particles needs to be shallow enough to ensure a sufficient number of bowling balls and BBs so they will always work and remain repositionable.*

Tack, peel and shear properties

Microsphere adhesives and permanent PSAs differ substantially in peel, tack and shear (see Figure 2, Table 1). Microsphere adhesives exhibit low peel-adhesion forces as measured by 180-deg peel adhesions and loop tack tests. The peel test measures the force required to pull a laminate from a substrate with an angle of 180 degs at a constant rate. In microspheres, these values are typically low and usually measured in grams, whereas permanent PSAs are measured in lbs and should create a "destruct bond" between face stock and the substrate strong enough to damage them.

Microspheres also produce low initial loop-tack bonds to a substrate. Loop tack is a measure of "quick stick" or tackiness of the adhesive and its ability to bond to a surface without any force. As with peel testing, loop tack of microspheres is typically measured in grams, not lbs, underscoring the stickiness of permanent PSAs over microspheres.

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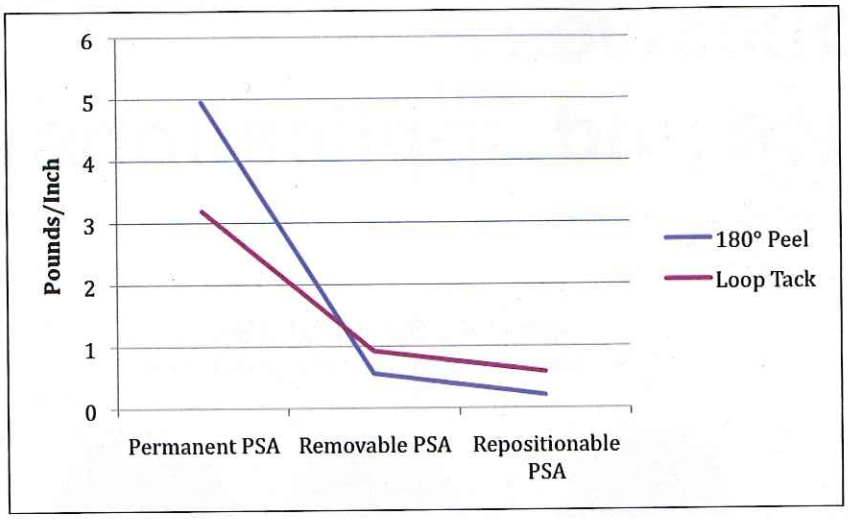

FIGURE 2. *Microsphere adhesives performance characteristics — 180-deg peel and loop-tack tests*

TABLE 1. *Microsphere adhesives performance comparison*

Microsphere Adhesives Performance Comparison (on film)			
Performance Test	**Permanent PSA**	**Removable PSA**	**Repositionable PSA**
180-deg Peel	4.95 C	0.554 A	0.205 A
Loop Tack	3.19	0.92	0.581
178-deg Shear	100 C	107 C	n/a
	C= Cohesive		
	A= Adhesive		

A third performance property of PSAs is shear. Shear measures the internal strength of the adhesive to hold a static load in the same plane as the face stock and is usually measured in minutes. Shear values of microspheres are extremely low and thus are not measured.

Advanced tech boosts versatility

A recent advancement in microsphere technology takes the concept of spheres a step further, greatly broadening application possibilities for repositionable adhesives. This newer technology varies the sizes of the larger particles from 20 to 80 microns. Different tack, peel and shear properties expand the type of substrates suitable for use with these microspheres. They adhere to the usual substrates, such as paper, cardboard, films, wood and ceramic (see Figure 3). At the same time, they also adhere, over and over again, to numerous other substrates that typically require special adhesive formulations. These additional substrates include metal, painted surfaces, tinted windows, refrigerators, walls, cabinets and photos.

Contemporary microsphere technology further expands application versatility, as well as the ability to work on different coaters through varied viscosities, percentage of solids and pH values. One microsphere no longer fits all. The technology has evolved into an adhesives category that includes the right repositionable adhesive for a given application. In fact, converters and coaters now can simply "dial in" physical and performance properties to tailor adhesives for specific applications. If the ideal adhesive isn't in the line, then it can be made to order.

Other properties

Today's advanced microspheres exhibit several other desirable characteristics that can help converters and coaters meet critical project requirements.

These PSAs won't yellow when exposed to either heat or ultraviolet light. Some adhesives will turn a yellowish brown color upon heat or UV exposure. A colorimeter measures an adhesive's tendency to yellow and assigns a corresponding "b" value. In general, the higher the "b" value, the more yellowish-brown the adhesives will appear. Low "b" values, as measured in microsphere PSAs, are important when clear films are used as backing materials or overlaminates to protect graphic images.

Additional capabilities enable contemporary microspheres to meet most requirements in the manufacture of labels and tapes or the creation of packaging and other goods. They can be screen-printed without compromising long-term performance. They also can be printed, die-cut and transfer-coated. Further, these microspheres are acid-free and will not damage delicate substrates, such as photographs, over the long term.

Microspheres have come a long way from their original use as an adhesive strip on the back of repositionable notepaper. Today, they can be used to screen-print or print electronic skins for cellphones and laptops. They help shelf-edge labels stay put on the grocery store shelves and enable them to be easily replaced when prices change. Microspheres also make possible the newly expanded-content labels, increasingly appearing on detergents, fertilizers and other products. This label can be lifted and opened to reveal additional product information – and then reaffixed to the package for subsequent reference. And microsphere adhesives have made their way into the world of crafts, on reusable sewing patterns, scrapbooking pieces and more.

FDA approval for food packaging

Advanced water-based microspheres have gained FDA approval for indirect food contact, opening new opportunities for the use of repositionable adhesives in food packaging. A prime example — microspheres are less expensive than conventional methods for sealing opened bags or pouches. Consumers need only apply a touch of pressure

to the adhesive strip to repeatedly seal in freshness. Packaging possibilities reach beyond food to other consumables that must remain fresh in their original containers.

Conclusion

Recent advancements in microsphere technology open numerous opportunities for creative packaging, as well as labels and tapes. Today, converters and coaters can order special microsphere products, customized to specific applications. Inherent characteristics of microspheres, coupled with the newfound ability to vary key performance properties such as peel, tack and shear, enable the industry to fully tap the potential of microsphere adhesives. ■

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FIGURE 3. *Various microsphere-adhesive applications*