USING NOVEL EMULSION BASED PSAS IN HIGH-PERFORMANCE TAPE APPLICATIONS

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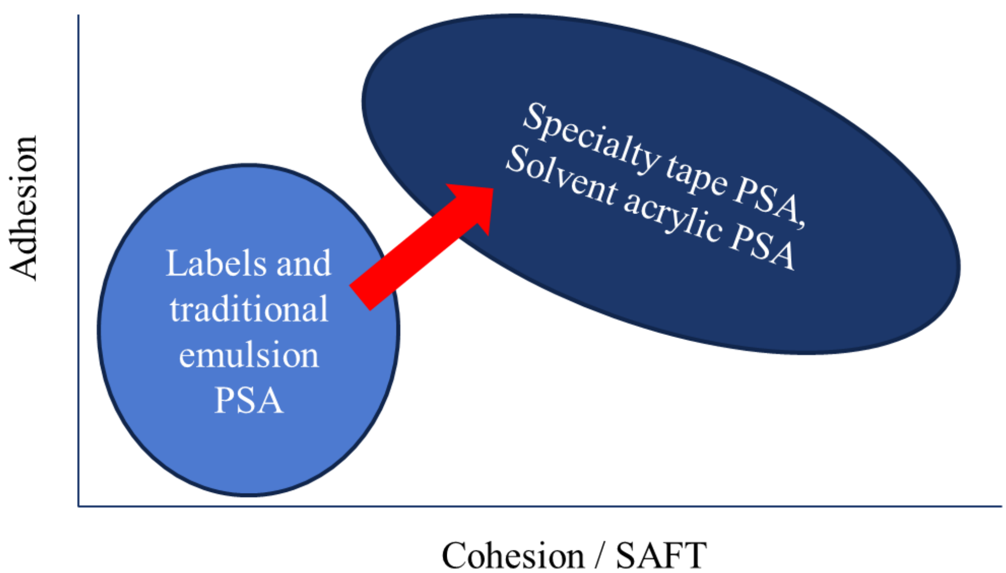
Introduction:

Pressure sensitive adhesives (PSAs) have become more popular in high demanding applications in tapes and labels. Many high-performance pressure sensitive adhesive applications are dominated by solvent acrylic PSAs and radiation curable PSAs because they can achieve much higher cohesive strength and heat resistance than other technologies, including typical emulsion PSAs. Due to these performance limitations, waterborne emulsion PSAs are used in less demanding applications. Waterborne acrylic PSAs provide many advantages such as high solids, lower cost, low hazard, and environmental benefits. With these advantages of emulsion PSAs, industry has been pushing the limits of emulsion technologies to close the performance gaps between emulsion and other high-performance technologies.

Figure 1: Current emulsion technologies



A new waterborne technology with excellent adhesion and high temperature properties has been developed which can rival existing solvent acrylic and radiation curable technologies that are currently used in high performance applications. The high temperature resistance is measured by Shear Adhesion Failure Temperature, or SAFT (PSTC-17 test method). SAFT has been the biggest limitation of waterborne PSAs versus radiation curable PSAs and solvent acrylic PSAs. In this paper, we will discuss high performance emulsion PSAs and their potential applications based on benchmarked data.

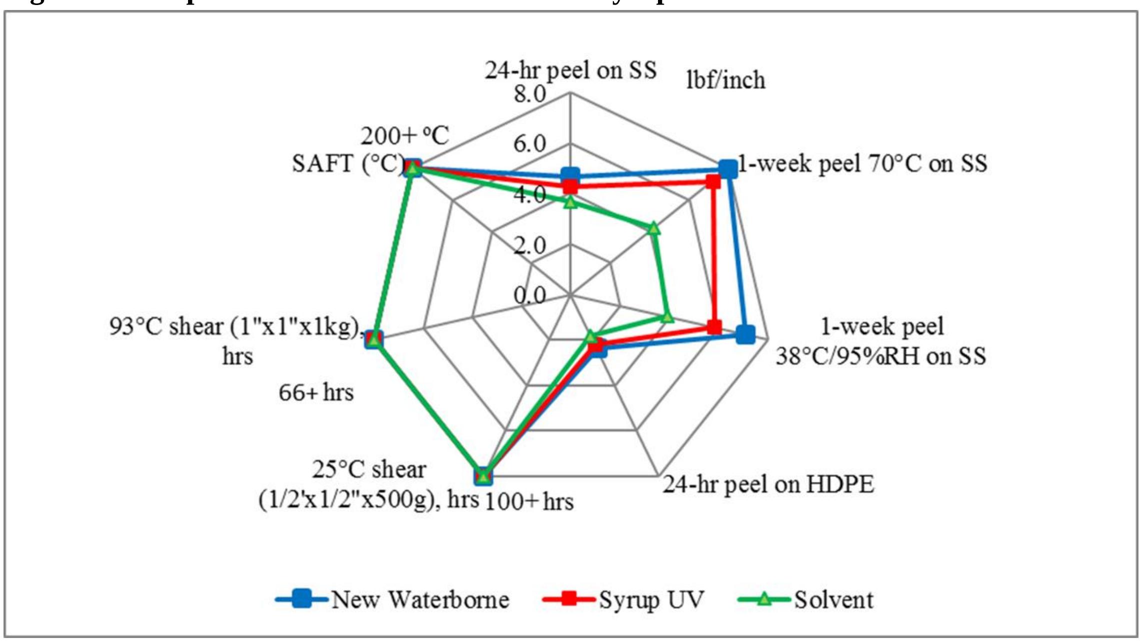
Adhesive Properties

Different types of crosslinkers and functional monomers can have various impacts on peel adhesion and high temperature performance. With waterborne emulsion PSA being a heterogeneous system, the crosslinking can be intra-particle, inter-particle or both after evaporation of water and the polymer particles start to coalesce. Unless care is taken in designing the crosslinking chemistry of the emulsion polymer, a non-uniform network can form leading to unpredictable or inconsistent performance. The new prototype emulsion PSA was developed having superior adhesion and high SAFT properties. The new waterborne PSA was benchmarked with a high-performance radiation curable acrylic PSA (syrup UV) and a solvent acrylic PSA.

Waterborne Emulsion PSA

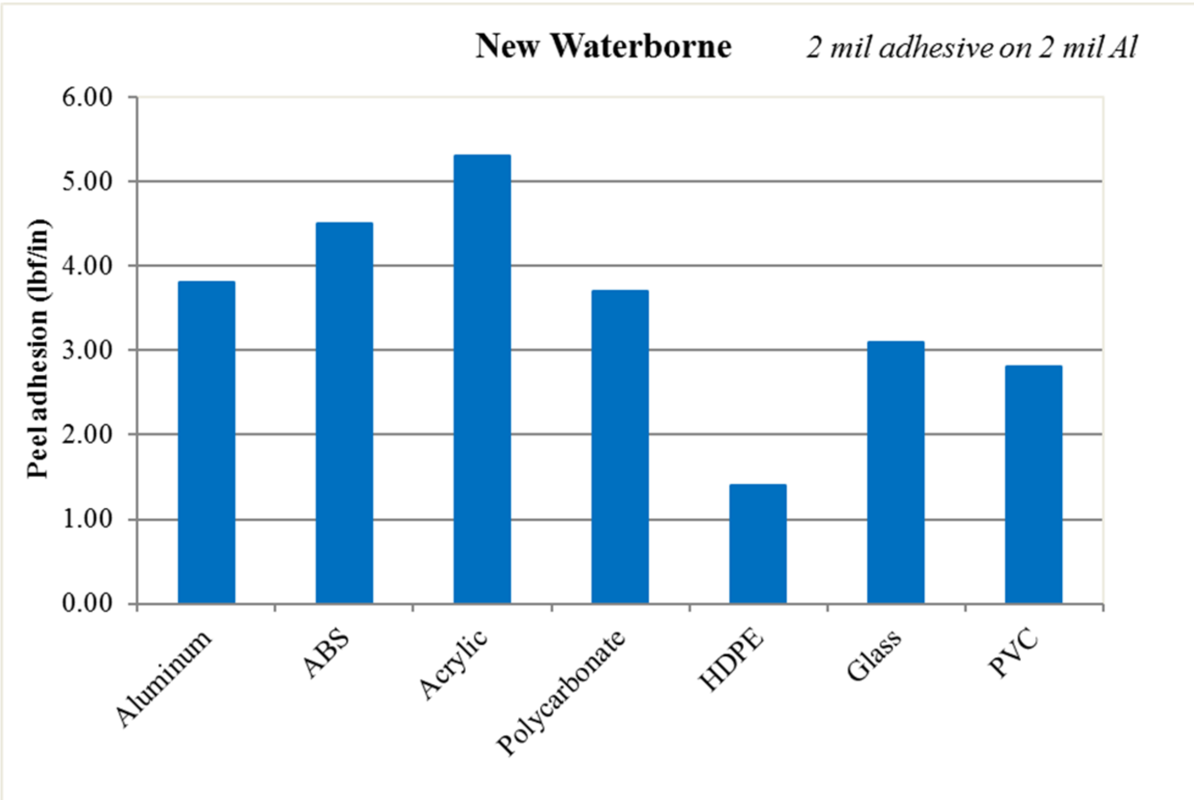
Semi-batch emulsion polymerization was used for the base polymer for the emulsion PSA study. The base contains 2-ethylhexyl acrylate, butyl acrylate, methyl methacrylate, styrene and acrylic acid with calculated glass transition temperature (Tg) of -40^{o}C. The test samples were prepared by coating on a 2 mil PET film, air dried for 30 minutes and then dried at 110^{o}C for additional 3 minutes. The dried adhesive coat weight was 50 grams/m^2. The adhesive films were cut into ½" and 1 inch strips for peel adhesion, cohesion and SAFT tests. This new prototype emulsion PSA has comparable adhesion performance and SAFT versus the radiation curable acrylic PSA (syrup UV) and solvent PSA as shown on figure 2.

Figure 2: Comparison of new emulsion PSA vs. syrup UV and solvent PSA.



With many tape applications requiring bonds to various substrates, the new emulsion PSA was tested on selected substrates. These tests were done with 2 mil aluminum foil backing and tested with 90º peel after 72 hours dwell on the substrates. The new waterborne adhesive provided excellent adhesion to various substrates.

Figure 3: Peel adhesion comparison on various substrates (90º peel with 72 hours dwell)



The new emulsion PSA was also tested for immersion in common fluids including water, gasoline, methyl ethyl ketone (MEK), isopropyl alcohol (IPA), and 10W30 motor oil as shown on Figure 4. This test was done on a 2 mil aluminum foil backing and tested with 90º peel. This emulsion PSA showed great performance and peel retention after immersion and no recovery.

Figure 5 shows the chemical resistance and temperature cycling of the new emulsion PSA. These tests were done with 7 day dwell on stainless steel plates.

Figure 4: Comparison of fluid immersion test (90º peel with 7 day dwell)

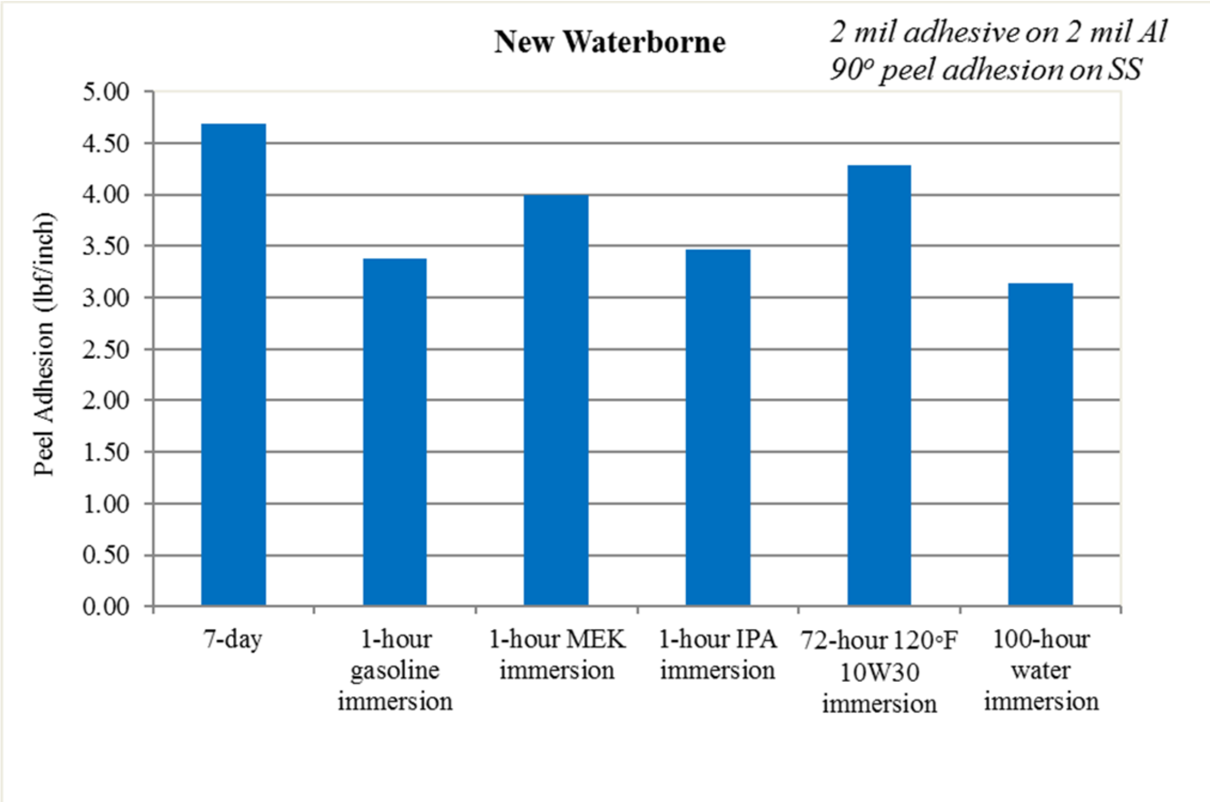
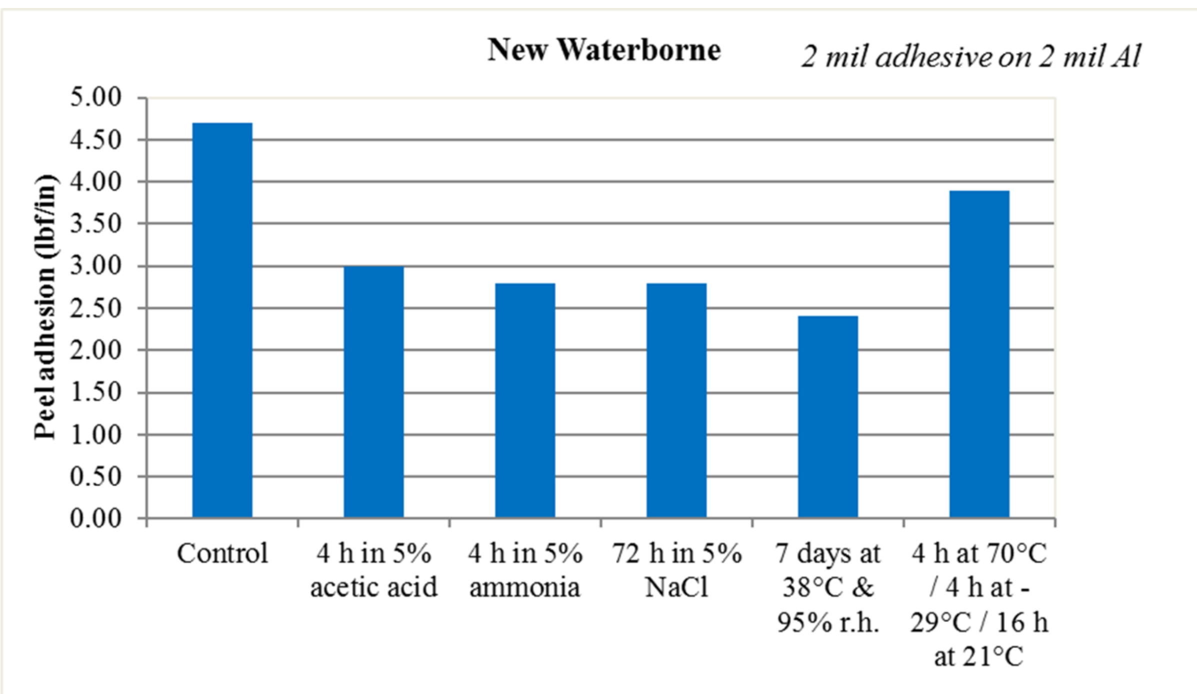


Figure 5: Chemical resistance and temperature cycling (90º peel with 7 day dwell)



Low Surface Energy Emulsion PSA

Many high performance applications require bonding to low surface energy (LSE) substrates such as high density polyethylene (HDPE) and polypropylene (PP). To achieve LSE bonding, a new emulsion PSA was tackified to develop a new LSE prototype emulsion PSA. This new LSE prototype has excellent adhesion ot LSE substrates while retaining high shear and tack. This prototype PSA was benchmarked with a LSE tape using UV syrup technologyas shown on Figure 6.

Figure 6: Comparison of new LSE Prototype PSA vs. syrup UV LSE PSA

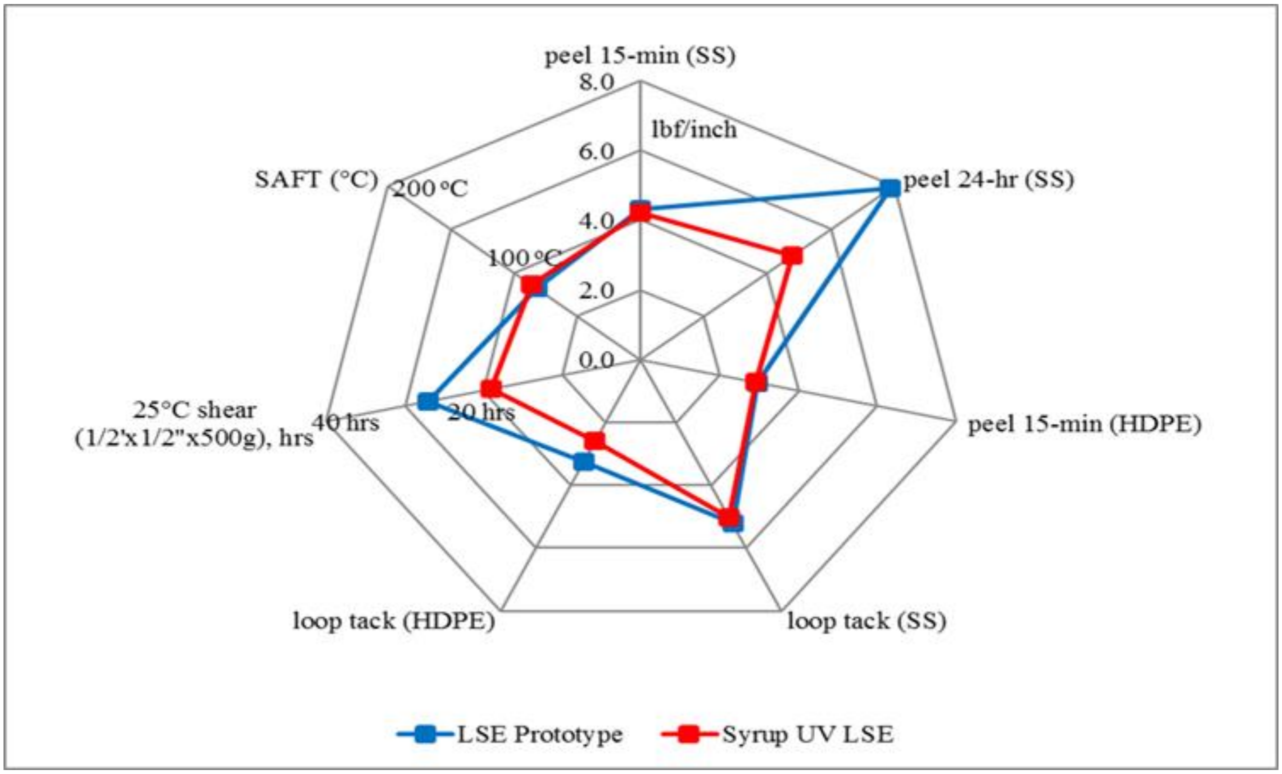


Figure 7 shows that LSE prototype PSA showed good adhesion to many different substrates.Figures 7 and 8 show that the LSE prototype PSA has excellent peel adhesion retention after fluid immersion, chemical resistance and temperature cycling tests.

Figure 7: Peel adhesion on various substrates (90º peel with 72 hours dwell)

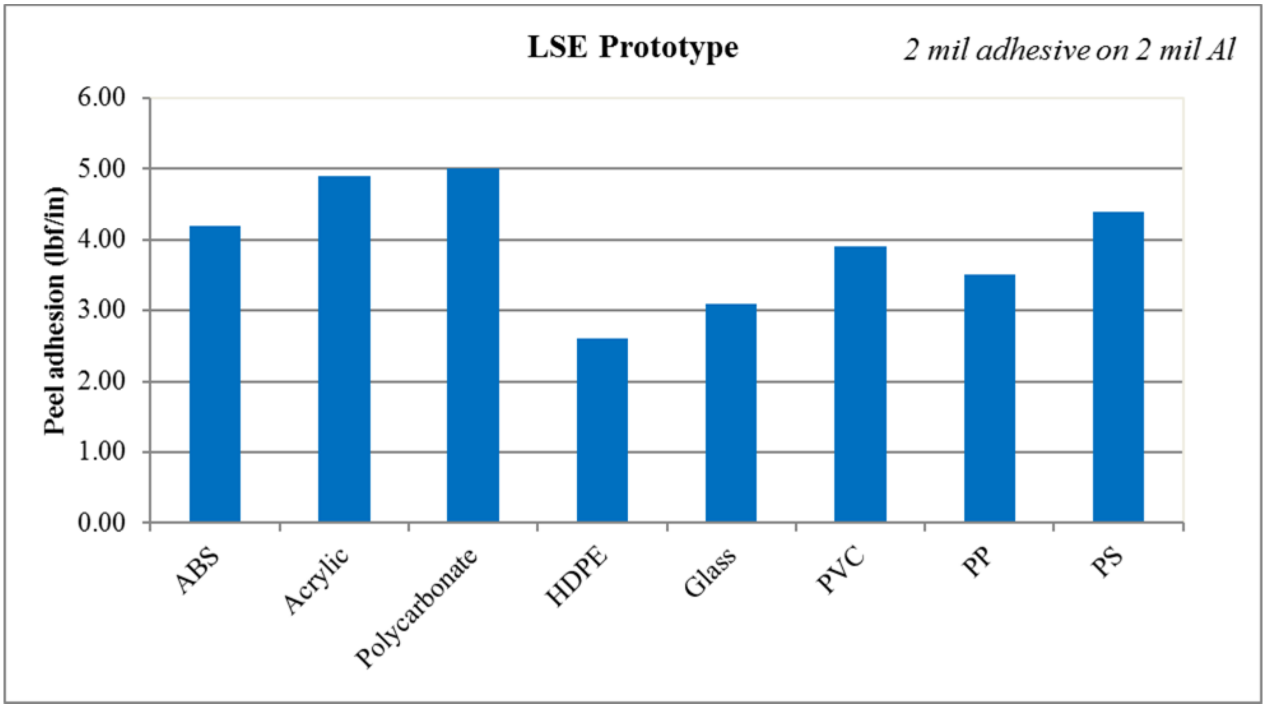


Figure 8: Peel Adhesion of fluid immersion test (90º peel with 7 day dwell)

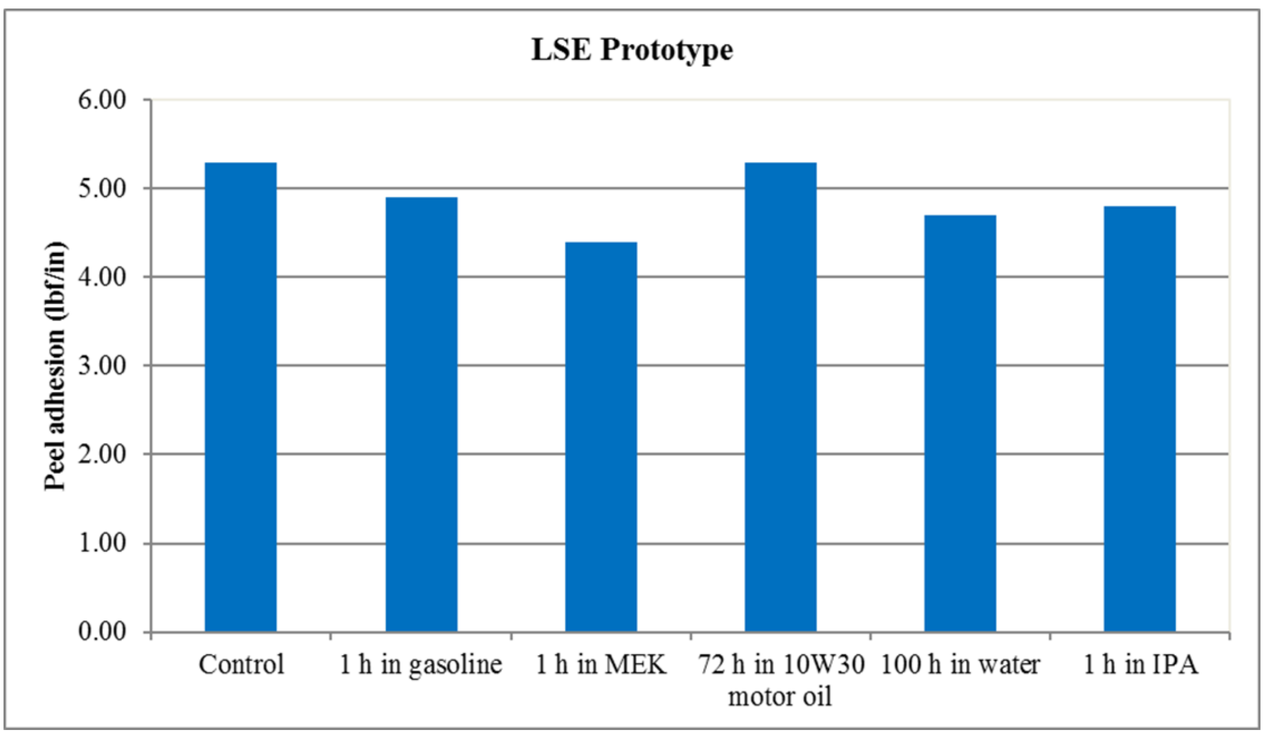
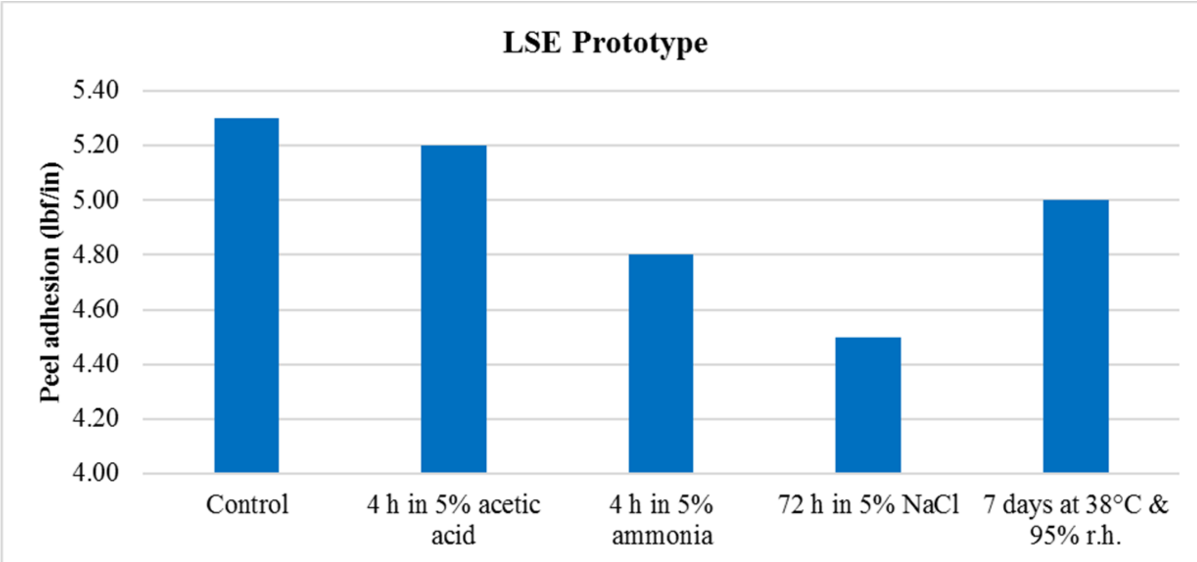


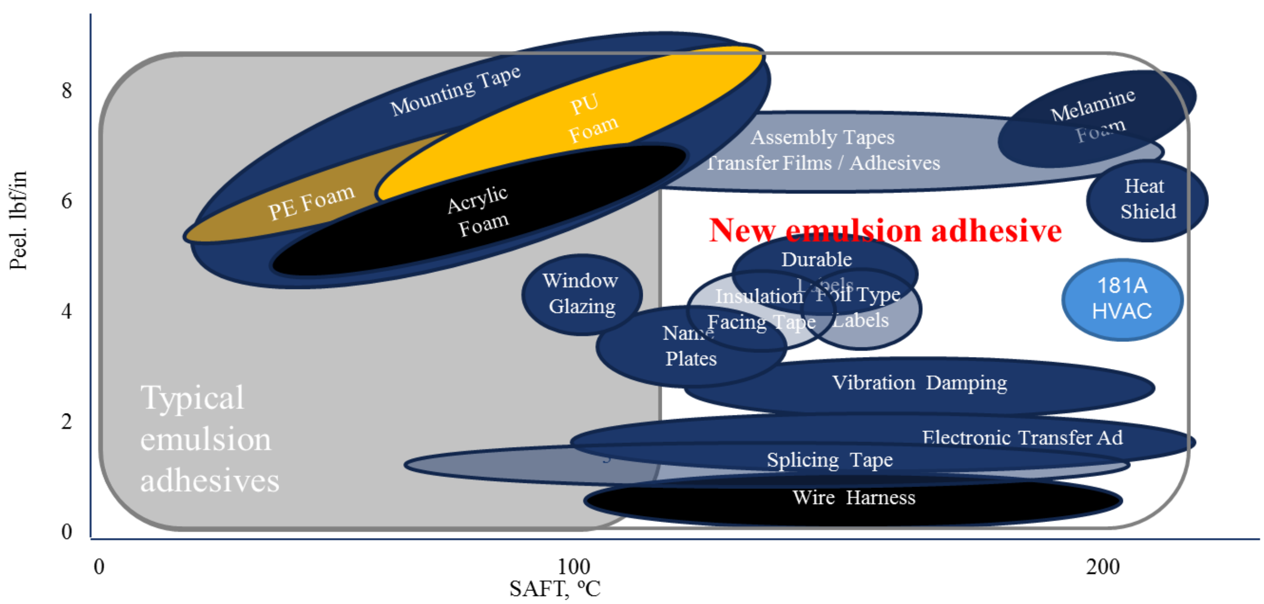
Figure 9: Chemical resistance and temperature cycling (90º peel with 7 day dwell)



<u>Possible Applications</u>

Many high-performance tapes require a balance of high adhesion together with excellent cohesion. With high SAFT properties and excellent adhesion, the new emulsion acrylic PSA can be used for many applications where typical emulsion acrylic PSAs were not used.

Figure 10: Application guideline



Foam bonding applications can be a challenge even with solvent and UV syrup PSA products. With corona treatment of foams, new waterborne PSA and LSE prototype show foam tear with wide range of polyurethane and polyethylene foams of various densities. Even with no corona treatment, softer grade polyurethane foam tests showed foam tear. This provides a viable alternative to solvent and UV syrup PSAs in this application.

Formulation of waterborne products can be customized to run on different coaters and can be manufactured with much higher solids than typical solvent based adhesives. Since emulsion adhesives do not typically contain flammable solvents, these adhesives also have an advantage of not having to monitor lower explosion limits (LEL) during the drying process and solvent oxidation or elimination process are not necessary. Together, these will allow the new emulsion adhesives to be coated faster and more safely than typical solvent based PSAs.

For internal automotive application, a high volatile organic compounds (VOC) content in the finished product can cause fogging problems and therefore cannot be used in the application. Some preliminary data for VOC contents and fogging tests using the dried film of the new emulsion adhesive show that this adhesive has similar VOC and fogging numbers to best-in-class products used in these applications.

Conclusion

Additional technology developments in lowering VOC and outgassing of the emulsion adhesives will open up new applications in aviation, electronics, and other automotive markets. With economic advantages and versatile formulation opportunities as well as environmental advantages, there will be additional high performance applications opportunities using new emulsion technologies.

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