

**RADIATION CURABLE PSAs:  
CURRENT STATUS AND APPLICATIONS**

**1. Introduction**

Currently there are three different types of radiation curable pressure sensitive adhesives available in the market:

UV-Acrylic hot melt pressure sensitive adhesives (HMPSAs)  
UV-Rubber based HMPSAs  
UV-polymerizable liquid PSAs

Despite the fact that these adhesives have been available in the market for more than 10 years now and many coating lines have been equipped with UV-lamps the technology has not been established to a great extent. After that long period of time it makes sense to discuss the reasons for that.

The UV-Acrylate technology has been developed to substitute solvent borne acrylic adhesives. The goal is to be able to apply these adhesives in a molten stage lead automatically to a lower molecular weight which results despite the cross-linking process in a lower shear performance. In addition to that the price level is substantially higher. Due to this fact the products are mainly used for niche applications. Also in the label area at big laminate producers this adhesive technology did not break through. In the graphic industry this is different. A growing number of label printers use the advantages of UV-Acrylic HMPSAs. It is possible to integrate the compact coaters, which are necessary for the converting of the adhesives, into a printing press. This type of application is gradually becoming a more popular option in the market.

In the tape area the shear resistance is in many cases not sufficient or the end application. But also here are some niche applications which use the advantages of this adhesive technology.

The primary intention of the development of the UV-Rubber based HMPSAs was to combine the advantages of the radiation curable HMPSAs and the conventional HMPSAs: Good compoundability and therefore a broad range of peel values in combination with very good shear performance and sufficient chemical resistance. In comparison to solvent borne acrylics the UV-Rubber based HMPSAs show slightly lower shear performance and chemical resistance. In addition to that the peel values have been on a lower level. Therefore the applications are primarily specialty tapes but there are also opportunities in the 'label stock' area for products with good temperature resistance. The converting can be done with standard coating equipment. The only thing which is needed additionally is UV-lamps.

The goal in the development of the UV-polymerizable liquid PSAs was to be able to give the graphic industry the possibility to produce self adhesive labels by means of existing machine equipment and therefore without any additional investments. The major advantage of these products is the possibility to convert the adhesives by means of standard screen or flexo printing devices which are equipped with UV-lamps. Normally the label printer converts UV printing inks with that kind of machines. The UV-polymerizable liquid PSAs can optionally be applied as dots, stripes or as full coatings. By that tool you have the possibility to determine the final adhesion by the kind of coating you produce. The number of applications is increasing steadily and is determined only by the creativity of the User.

During the following paper the above mentioned topics will be discussed.

- UV-Acrylic HMPSAs  
Properties and applications as  
No-Label-Look Label and wet wipe  
closures

- UV-Rubber based HMPSAs  
Properties and application for sound Dampening in the automotive area
- UV-polymerizable liquid PSAs  
Properties and application for booklets

## 2. UV-Acrylic Hot melt pressures sensitive adhesives

The basic advantages of this technology are well known in the industry. Beside high transparency and sufficient high temperature performance they offer a good to very good chemical resistance. Furthermore UV-Acrylic HMPSAs do not contain free photo initiators which may migrate. Therefore an approval for indirect food contact according to FDA 175.105 is given. If properly cross linked slitting and die cutting behavior is excellent. Maximum coat weight is 100 gsm. The application can optionally be done by means of a roller coater or a slot die at temperatures between 110 and 140 °C. To produce a 'No Label Look' Label it is recommended to use a contact less coating system. UV radiation is necessary. To obtain consistent end properties for the finished product it is essential to determine the process window, where the peel/tack and shear performance is balanced best for the end application, in combination of the machine and the adhesive.

### Applications

Applications are: 'No Label look' labels, wet wipe closures, temperature resistant tapes and a number of medical products.

Application as a No Label Look label is discussed in the following part.

### 'No-Label-Look'

#### Requirements of a 'No Label Look' label

Besides high transparency there are other benefits such as good resistance to the products inside the bottles, temperature resistance and good adhesion to low surface energy surfaces. In addition to that the label has to be applied with very high speeds.



### Construction of a No Label Look label

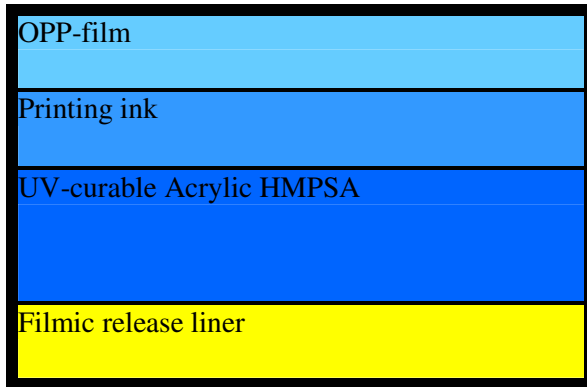
#### Currently used technology

Protective film
Laminating adhesive
Printing ink
OPP film
Adhesive
Filmic release liner

In a typical current construction the green section, which is the clear to clear laminate, has to be bought in by the label printer. Available clear to clear laminates are relatively expensive and the choice is limited.

The blue section describes the process steps that a printer has to perform: Printing on the laminate, application of a laminating adhesive and afterwards lamination with a protective film. This protective film has to full fill three key tasks: Protecting the printing ink from scratching, improvement of chemical resistance and protection of the content of the bottle from interactions with the printing ink.

**New technology**



In the above construction of the label the OPP-film is reverse printed, coated with UV-Acrylic HMPSA, cross linked and laminated with the release liner.

The advantages in this construction are obvious: unlimited choice of adhesive (re-openable, re-positional or permanent), no need of laminating adhesive and protective film.

With this construction it is possible to save up to 20% of material costs. But this is not the only advantage: The label printer will be more flexible in terms of lead times and batch sizes. Due to today's competition and cost driven market the label printers now have a unique opportunity to be one step ahead of their competition and therefore better securing their future business.

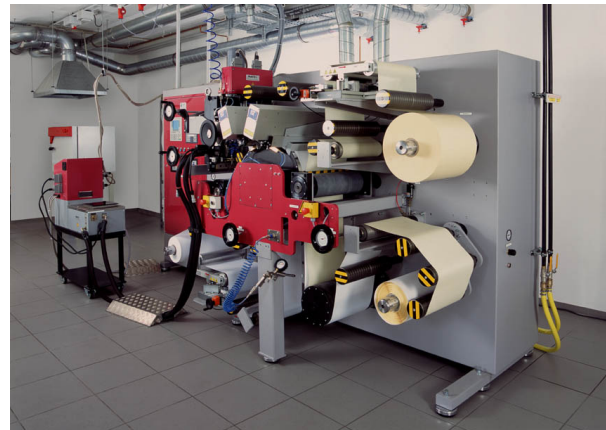
**Adhesives**

The following table shows to products which have been developed especially for No Label Look applications, both of the products shown have been converted with 10 m/min and cross linked with 1x100%Hg (240 W/cm). Coat weight is 25gsm.

	<b>Novarad RC 21151</b>	<b>Novarad RC 21200</b>
<b>180° peel strength acc. to FTM1 20min</b>	11,6 N/inch	12,5 N/inch
<b>180° peel strength acc. to FTM1 24h</b>	12,7 N/inch	15,7 N/inch
<b>Looptack acc. to FTM9</b>	16,3 N/inch	22,4 N/inch
<b>Shear strength acc. to FTM8 (1kg/inch<sup>2</sup>)</b>		
<b>23°C</b>	>24 h	>24 h
<b>40°C</b>	>24 h	11 h
<b>SAFT (0,5°C/min with 0,5kg)</b>	>180 °C	>180 °C
<b>Rolling Ball</b>	20 cm	21cm

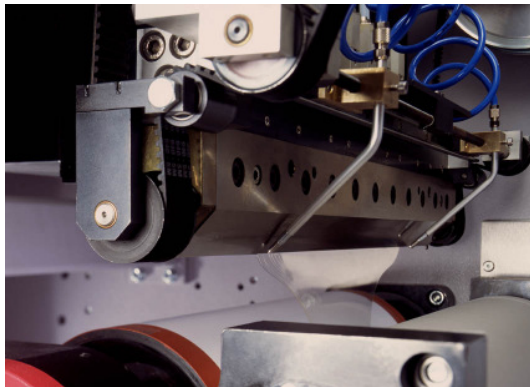
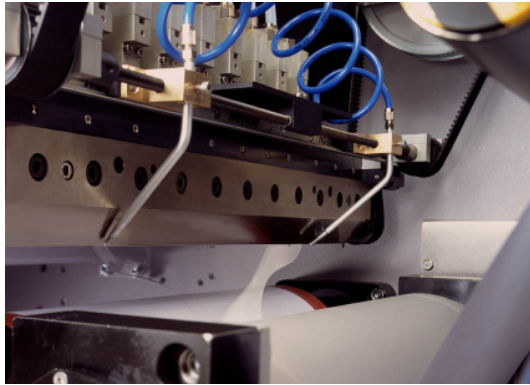
Novamelt offers its customers a unique service in the adhesive industry, the ability to produce 'No Label Look' samples in controlled lab environment.

Recently investing in a new curtain coater the machine is now ready to use for our customers to run their trials.



**Technical Data:**

Coating width:	70 to 350mm
Reel diameter:	max. 400mm
Line speed:	max. 50 m/min
UV-Lamps:	IST 2x200 W/cm Including intensity-control



This lab coater can produce sample reels with preprinted material which afterwards can be die cut and slit in the printing press. These labels can be used for first testing and then if suitable as samples to your customers.

### Wet Wipe closures



### Requirements

Besides of very soft opening the package has also to be closed again for several times afterwards. Due to the chemically aggressive ingredients for example in household wipes for sanitary areas the chemical resistance of the adhesive has to be excellent. In addition the adhesive has to work even when contaminated with the ingredients of the package.

### Adhesives

For this application Novamelt has developed the adhesive grade Novarad RC 24340 which full fills all of the requirements.

### 3. UV-Rubber based Hot melt pressure sensitive adhesives

This technology is based on a UV-curable SBS-rubber. For crosslinking two techniques are possible: UV-curing or electron beam curing. The following explanations are focused on UV-curing only.

To start the crosslinking reaction by means of UV-radiation a photoinitiator has to be added. Despite the use of free photoinitiators it is possible to formulate adhesives which have an approval for indirect food contact according to FDA 175.105. The approval depends on the choice of the initiator.

The active species which is crosslinked are the remaining double bonds in the Butadien molecule.

Due to the fact that these adhesives are compoundable in the same way as standard rubber based Hot Melt adhesives a broad range of peel values is achievable. Because of the free choice of photoinitiator it is possible to enhance the reactivity of the system.

The most important properties of UV-Rubber based adhesives are very high adhesion to non polar surfaces, good adhesion at lower temperatures, outstanding high temperature performance in terms of shear and sufficient chemical resistance to oils, fuel, plasticizers, vinegar and water. Coat weights of >100gsm are feasible.

For converting standard coating technologies such as roller coaters and slot dies are possible. Coating temperatures are between 140 and

170°C. To achieve the outstanding shear performance it is absolutely necessary to crosslink the adhesives.

Also in this case it is mandatory to determine the curing window of the machine/adhesive combination.

### Applications

Due to very good shear performance the main application field is the tape area where products such as masking and transfer tapes are needed. An important application is for sound dampening in the automotive industry. For the label area you can think of temperature resistant labels.

Consequently the application for sound dampening in the automotive industry is discussed.

### Sound dampening

For sound dampening in automobiles self adhesive bitumen plates are used. The function of these plates is to prevent all kinds of noises to come inside the car.

### Requirements for sound dampening

Besides a very good adhesion also a very good high temperature and shear performance is demanded. An additional requirement for the car manufacturer is a sufficient chemical resistance because there are also some application areas around the engine.

The plates have to work for the life cycle of a car.

### Adhesives

In the following table are displayed two adhesives which full fill the demands of this and of similar applications.

Both products have been coated with a line speed of 15m/min and crosslinked with one Hg-Bulb at full power (240 W/cm). Coat weight is 50gsm.

50gsm PET	Novarad RC 51102	Novarad RC 51108
180° peel strength acc. to AFERA 4001	13,2 N/inch	21,1 N/inch
Looptack, acc. to AFERA 4015	18,8 N/inch	39,2 N/inch
Shear strength acc. to AFERA 4012 (N/inch <sup>2</sup> )		
23°C	40 N	40 N
40°C	20 N	20 N
70°C	10 N	10 N
SAFT (0,5°C/min with 0,5kg)	>180 °C	>160 °C
Rolling Ball	14 cm	25 cm

For a different application Novarad RC 51102 has been coated at 125 gsm on PET. Line speed: 10 m/min; One Hg-Bulb at full power (240 W/cm)

125 gsm PET	Novarad RC 51102
180° peel strength acc. to AFERA 4001	15 N/inch
Looptack, acc. to AFERA 4015	33,7 N/inch
Shear strength acc. To FTM8 (h/inch <sup>2</sup> )	
23°C 1kg	>24 h
40°C 1kg	>24 h
70°C 1kg	>24 h
176°C 0,5kg	>100 h
SAFT (0,5°C/min with 0,5kg)	>180 h
Rolling Ball	7 cm

As can be seen in the above table it is possible to fully crosslink Novarad RC 51102 at 125°C. You get a product with outstanding shear properties even at temperatures above 170°C.

#### 4. UV-polymerizable liquid pressure sensitive adhesives

Due to the fact that this system has been developed for a totally different area it has to be observed independently from the other two mentioned systems.

Most important property of this adhesive technology is that they are liquid at room temperature and therefore are coatable by means of standard printing techniques.

After coating the Adhesives have to be polymerized with UV-radiation.

The backbone of these adhesives consists of Acrylate monomers and oligomers. In addition to that tackifier resins, photoinitiators and additives (eg for rheology improvement) are added.

UV-polymerizable liquid PSAs offer high transparency, high reactivity. Temperature resistance is also sufficient. An additional advantage is the possibility to achieve dot or zone coatings and therefore different peel levels.

#### Applications

All applications at this time are in the label area. Besides business forms, multilayer constructions and logistics labels also booklets are produced.

#### Booklets



#### Requirements

The booklet construction requires three different self adhesive zones: The first one is used to stick the booklet to the packaging (eg shower gel, lotion...). For this a standard laminate can be used. The second zone is that part which assembles the booklet permanent. The third zone is the openabel and recloseable part.

Our UV-polymerizable liquid PSA Novarad RCL 6011 can full fill the demands of zone two and three. The permanent area is fully coated and the reopenable are is dot coated.

#### Adhesives

For the production of these label constructions two adhesives are available. As a permanent grade Novarad RCL 6011 is recommend, where the peel and tack values are between 12 and 14 N/inch. As a removeabel grade we offer Novarad RCL 6051. The achievable peel and tack level is around 4 N/inch.

#### 5. Summary

The customer has the possibility to choose between all three different types of UV adhesives depending on his applications.

UV-Acrylic HMPSAs for No Label Look and other label applications.

UV-Rubber based HMPSAs for tape applications where high shear and high temperature performance is required.

UV-polymerizable liquid pressure sensitive adhesives for converting in a printing press for speciality label constructions.

If you are interested in the UV-systems mentioned above please do not hesitate to contact us.