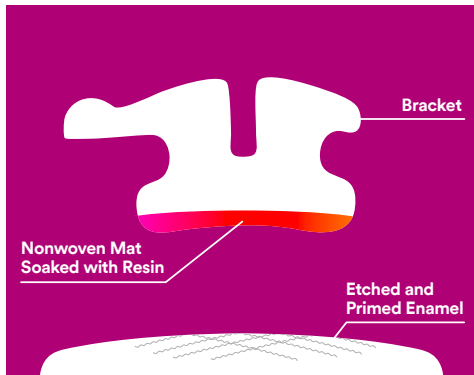


3M Science.
Applied to Life.™

3M™ APC™ Flash-Free Adhesive

David K. Cinader, 3M Product Development Specialist / Mathazin Aung, 3M Product Development Engineer
Rachel Ugai, 3M Technical Service Engineer / Alan Conley, 3M Packaging Engineer



Orthodontic adhesives, including previous 3M™ APC™ Flash-Free Adhesives, have traditionally been highly filled pastes descended from dental restoratives. Orthodontists usually consider removal of excess adhesive flash after appliance seating an inherent part of their bonding procedure. If not removed, exposed adhesive flash could discolor or stain. Further, flash removal is a time-consuming and stressful task for many orthodontists as their careful positioning of appliances on teeth, as well as the bond integrity, could be compromised by bumping the appliance. Furthermore, any reduction in the time that the patient spends in cheek retractors enhances comfort.

We recognized flash removal as a persistent pain point and developed a new class of APC adhesive that would not require this step by means of a compressible material and a lightly filled resin formula.

An Innovative Solution to a Common Problem

APC Flash-Free Adhesive is a unique composition of a compressible nonwoven mat, soaked with a relatively low viscosity adhesive resin. When an APC Flash-Free Adhesive-coated appliance is seated in place on a tooth, the compressible mat lets the resin seep out to fill the space between the appliance bonding base and the tooth. The surface tension of the low viscosity resin allows it to wet the tooth surface well and form a fillet around the bonding base, instead of forming the irregular clumps of adhesive flash typically produced by paste adhesives. The fillet is typically smooth and similar to a meniscus seen at the interface of a liquid and laboratory glassware. In this application, the size of the fillet is constrained by the precise amount of resin determined for each type of tooth. As a result, APC Flash-Free Adhesive appliances offer a bonding procedure with no need for the flash removal step so that orthodontists can focus on appliance positioning.

Specially Designed Nonwoven Mat

The term “nonwoven” generally applies to fabric-like materials made of long, entangled fibers. Nonwovens differ from woven or knit fabrics in that they are randomly arranged much like a bowl of noodles. Examples of 3M nonwoven brand products range from Filtrete™ filters and Thinsulate™ insulators to Nomad™ doormats and Scotch-Brite™ abrasive pads. Depending on the needs of each application, material properties are typically tailored through selection of fiber composition and processing technique. For APC Flash-Free Adhesive, the nonwoven material needs to provide a degree of compressibility in the direction (z) of seating the appliance in order to accommodate a range of tooth contours, yet not expand in the direction (x-y) as flash around the bonding base. Additionally, its thickness and loft need to provide similar adhesive bond line thickness to paste adhesives so that orthodontic treatment outcomes will be unaffected.

The required nonwoven material was developed internally within 3M and is a web of micron-sized polypropylene fibers, shown close-up in Figure 1. The web is made with 3M’s expertise in web processing so that the fibers are entangled enough so as not to unravel as small pieces of mats are cut and applied to the appliances while still providing the necessary thickness and loft.

APC Flash-Free Adhesive mats are precisely cut from the web to fit and align with the shape of each appliance’s bonding base. Figure 2 shows a mat as assembled on a bonding base. When attached to the appliance, the defined mat configuration helps ensure that the resin reaches the edges of the bonding base, creating a well-formed fillet.

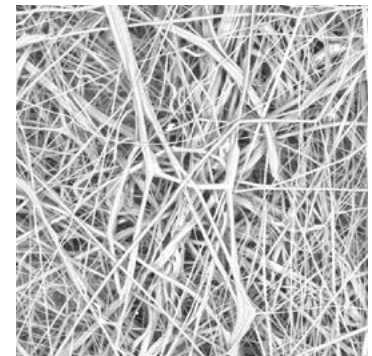


Figure 1:

The nonwoven fabric used in APC Flash-Free Adhesive consists of randomly oriented, entangled fibers.



Figure 2:

The size and shape of the nonwoven mat is custom designed for each bonding base. The mat is attached to the bracket with a small amount of cured resin.

A Unique Resin Design

The resin used in APC Flash-Free Adhesive is unique among orthodontic adhesives. It is of a much lower viscosity and has a surface tension designed to wet the enamel and form the filleted edge. Additionally, the resin amount is critical to creating a well-formed fillet. Multiple in vitro studies were conducted with doctors to define an acceptable fillet and define the resin loading for each bracket.

The most important job of an adhesive is to provide a reliable bond. In adhesive joint design, well-formed fillets such as seen in Figure 3 is instrumental in distributing stress and contributing to a reliable bond. One indicator of the bond reliability of an orthodontic adhesive is the bond strength measured in laboratory tests. In Figure 4, the bond strength of APC Flash-Free Adhesive is plotted alongside that of well-received 3M™ Transbond™ XT Adhesive. It can be seen that APC Flash-Free Adhesive compares favorably.

Naturally, with any bonding system one is concerned with discoloration/staining of the bonding material. Extrinsic staining occurs mainly as a result of materials dissolved in the water that an adhesive may absorb while in use. APC Flash-Free Adhesive has been formulated with very hydrophobic monomers to minimize the amount of material that will be absorbed during treatment.

An Integrated Delivery System

Delivering a pre-coated bracket to the customer is a unique challenge. A new package was designed which minimally contacts the adhesive to ensure that the correct amount of resin remains on the bracket. It is shown in Figure 5 and consists of tapered bars which touch the bracket bases on the occlusal and gingival edges only.

The package was designed to retain the same ease of use that customers have come to expect from the 3M™ APC™ Adhesive System blister. Brackets may be gripped in the same manner in which users are accustomed and pulled in a direction perpendicular to the blister bottom. Alternatively, a gentle rocking motion in the mesial-distal directions can be employed to ease removal (Figure 6A-C).

Ease of removal from the package must be balanced against surviving the rigors of shipping through a global supply chain. To this end, a comprehensive test was conducted to ensure that the bracket would not come loose during exposure to prolonged harsh vibration and multiple sharp shocks.

Ease of use extends to the manner in which the product fits into the orthodontic practice. The original APC Adhesive System was designed to provide a dedicated “inventory to chairside” solution. The APC Adhesive Inventory Dispensing System (IDS) includes a back-up storage unit, stackable dispensing drawers and set-up trays. The outside of the APC Flash-Free Adhesive blister package is identical to that of APC PLUS adhesive packaging so that it fits into the existing IDS components, providing both new and existing users the convenience of the APC system.

Conclusion

The APC Flash-Free Adhesive Coated Appliance System combines multiple technologies to create an innovative bonding system. The resin, nonwoven mat and unique package come together to deliver an easy-to-use solution with no flash to clean up.



Figure 3: Bracket bonded with APC Flash-Free Adhesive, showing fillet around bracket base.



Figure 4: Bond Strength of APC Flash-Free vs. Transbond XT adhesive



Figure 5: APC Flash-Free Adhesive-coated brackets are held in place by structures that grip the occlusal and gingival edges of the bonding base.

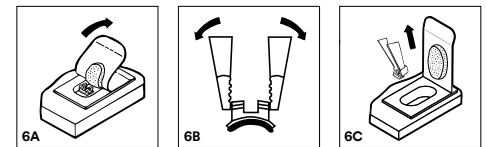


Figure 6A-C: Suggested method for bracket removal. Open lid with peeling motion. Grasp bracket tie-wings and gently rock side to side. Remove from blister by lifting.

To learn more about APC Flash-Free Adhesive visit [3M.com/APCFF](https://www.3m.com/APCFF)



3M Oral Care
2510 Conway Avenue
St. Paul, MN 55144-1000 USA
1-800-423-4588
[3m.com/APCFF](https://www.3m.com/APCFF)

**3M Canada
Health Care Division**
300 Tartan Dr.
London, ON N5V 4M9 Canada
1-800-443-1661

Reprinted from *Orthodontic Perspectives*
Innova Vol. XX No. 1, 2013.

3M, APC Flash-Free Adhesive, Filtrete, Thinsulate, Nomad, Scotch-Brite and Transbond are trademarks of 3M. © 3M 2022. All rights reserved. Please recycle. Printed in U.S.A.