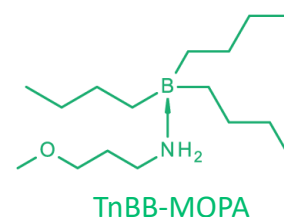
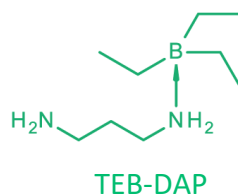


Initiate with Callery's Stabilized Alkylborane Complexes



Callery's alkylborane-amine complexes overcome the slippery challenge of bonding polypropylene (PP) and other low surface-energy materials such as thermoplastic olefins (TPO) by chemically GRAFTING monomers to the polymer backbone!

- Ideal for two component (2K) systems
- Triggered with acrylic acid or isocyanates (any amine scavenger)
- Perfect for methacrylate-type adhesives
- Works with a wide range of acrylate and methacrylate monomers
- Incredible bond strength to PP and many traditional substrates
- Fast cure times possible
- No primers, plasma, corona or flame treatment needed
- Cure at or below room temperature!
- No UV lamps needed to initiate cure
- No refrigeration required during storage

Applications with PP and TPO are growing faster than any other plastic. Markets from automotive to commercial signage are benefiting from PP's low cost and excellent physical properties. These markets need a strong adhesive for quality part fastening!

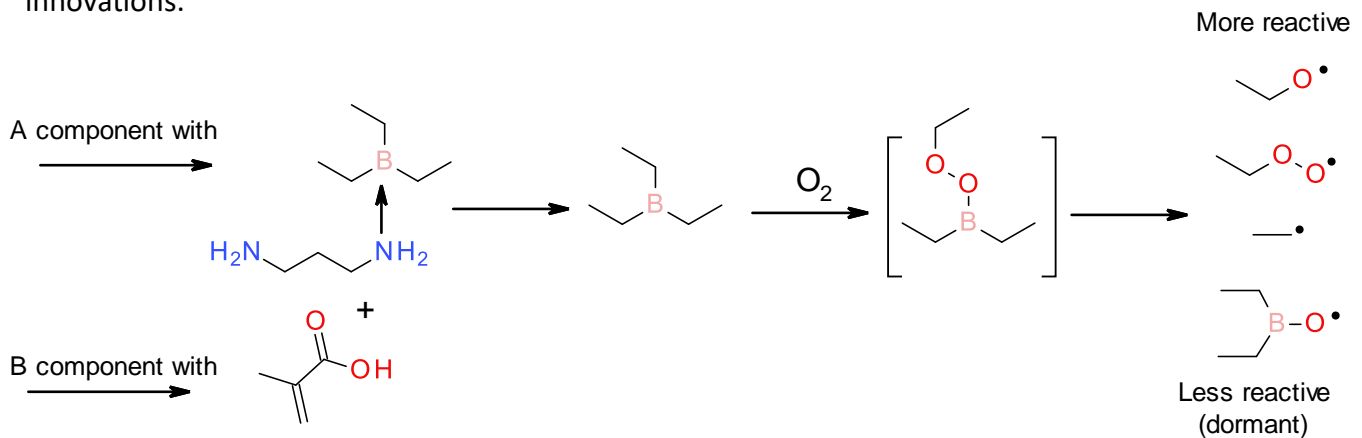
Use Callery's amine-stabilized alkylboranes to formulate an adhesive to help manufacturers solve their bonding issues! We have adhesive formulation examples that bond polypropylene to nearly anything!

Alkylborane-Amine Complexes

A Safe, 2-Component Initiator

Instant Free Radicals – powerful & plentiful at any temperature.

Our 2K initiator system uses acid/base chemistry to convert a stable alkylborane-amine complex to a reactive intermediate that instantly produces free radicals as it reacts with oxygen entrained in your system or from the air. Free radicals will only develop after mixing with acid or other amine scavenger. No UV light source or heat are required to generate free radicals. Our alkylborane-amine complexes can be stored without refrigeration or other extraordinary measures. Whether you use it for “Room Temperature Cure” adhesives, sealants or coatings or for the powerful free radicals for bonding low surface energy polymers via a grafting mechanism – Callery’s stabilized alkylboranes are perfect for your innovations.



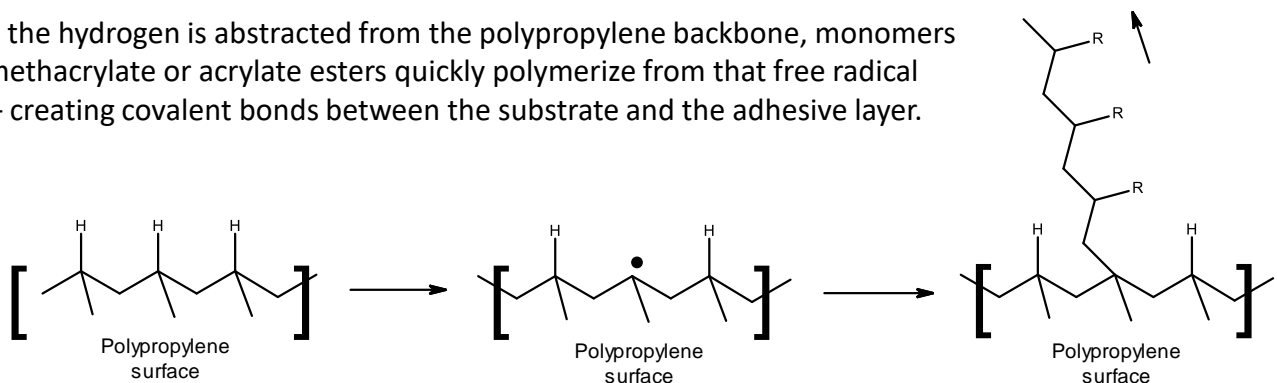
Adhesives that “Graft” to Low Surface Energy Substrates

Grafting: covalently bonding new monomers to an existing polymer.

Low surface energy substrates like polypropylene are commonly referred to as “difficult” or “challenging” materials. Traditional adhesives are ineffective on untreated polypropylene because the adhesive formulation must have a lower surface tension than the PP to “wet out” and adhere. That requirement is by-passed if a resin mixture forms a covalent bond (“grafts”) to an atom on the substrate.

Published articles suggest the mechanism forming the exceptionally strong adhesive bonds to polypropylene are the result of alkoxy radicals pulling hydrogens from the polypropylene backbone.

Once the hydrogen is abstracted from the polypropylene backbone, monomers like methacrylate or acrylate esters quickly polymerize from that free radical site – creating covalent bonds between the substrate and the adhesive layer.



Alkylborane-Amine Complexes

A Simple Option for “Room Temperature Curing”

Instantly cure adhesives, sealants, coatings, inks, ...

Many forces are driving the goal of “room temperature curing”. Reduced investment in ovens, less work-in-process (WIP), faster setup on multi-product production lines and even lower emissions. Because monomers are not heated for curing, lower emissions means decreased industrial hygiene issues and lower VOC reporting for state and federal regulators.

Alkylboranes-amine complexes have been used in a wide range of innovative applications – from thiol-ene chemistry (WO2015148319 A1 by 3M) to textured “ink” formulations on polymer films by Dow Corning in *ACS Appl. Mater. Interfaces*, **2015**, 7 (43), pp 23902–23911.

The possibilities are endless and we hear ideas everyday as customers call to discuss opportunities. We are here to discuss your opportunity – please call or email (724-538-1309, karl.matos@callery.com).

A Word on Safety

All reactive molecules must be handled with care.

Although our alkylborane-amine complexes do not require refrigeration like organo-peroxide initiators or azo-type initiators, be aware of proper handling procedures to maintain safety and quality of the product. Keep product in the original container. Purge with nitrogen before closing to prevent moisture from hydrolyzing product. Do not expose to acids, acid vapors or other amine scavengers like isocyanates, ketones or aldehydes. Our Product Steward will be happy to discuss in detail.

Why Not Just Use Dialkyl Peroxides?

Dialkyl peroxides make alkoxy radicals, but only at elevated temperatures.

Polypropylene converters have been using dialkyl peroxides as an alkoxy radical source for many years. “Bonding grades” of PP and TPO are made by grafting polar maleic anhydride to the polymer backbone during “reactive extrusion”. The polymer is physically melted and injected with dialkyl peroxides into the barrel of an extruder at 200 to 240 °C with various monomers. The extruded modified polymer string is immediately cooled and chopped into pellets for use by injection molders.

For adhesive formulations, dialkyl peroxides are just too stable for room temperature curing.

Heating adhesives and substrates to temperatures required for the dialkyl peroxide to decompose to alkoxy radicals will damage the appearance of the substrate, degrade the physical properties of the polymer and cause significant emissions of the monomers evaporating from the adhesive. Finally, rapid cooling of large assemblies is not possible because the cross section is too great to quickly remove the heat, thus warping may occur.

Alkylborane-Amine Complexes

A quick start in formulation for adhesives and other applications

Callery places a high value on intellectual property and we discourage the use of other company's IP without proper licenses or permission. However, expired patents are an excellent source of information. Alkylborane-amine complexes are actually a well known technology in the area of adhesives for low-surface energy substrates. Patents, initially by National Starch in the early 1990s and by Henkel, Loctite and 3M, are now expired prior art.

US Patents filed more than 20 years ago are now expired. A non-exhaustive list of expired patents referencing stabilized (and un-stabilized) alkylborane initiators are listed below. These patents are an excellent source of formulation information that is in the public domain.

Patent	Title	Assignee	Application Date
5,935,711	Organoborane amine complex initiator systems and polymerizable compositions made therewith	3M	Oct-96
5,912,433	Cable closure injection sealed with low surface energy adhesive	3M	Jan-97
5,883,208	Initiator system and adhesive composition made therewith	3M	Nov-96
5,872,197	Initiator system and adhesive composition made therewith	3M	Jun-97
5,834,532	Primer composition and curable composition	Sun Medical	Jun-97
5,795,657	Organoborane polyamine complexes and adhesive compositions made therewith	3M	Dec-96
5,718,977	Organoborane polyoxyalkylenepolyamine complexes and adhesive compositions made therewith	3M	Dec-96
5,691,065	Polymerizable compositions made with polymerization initiator systems based on organoborane amine complexes	3M	Mar-96
5,690,780	Polymerizable compositions made with polymerization initiator systems based on organoborane amine complexes	3M	Mar-96
5,686,544	Organoborane polyamine complex initiator systems and polymerizable compositions made therewith	3M	Aug-95
5,684,102	Organoborane polyamine complexes and adhesive compositions made therewith	3M	Dec-96
5,681,910	Organoborane polyoxyalkylenepolyamine complexes and adhesive compositions made therewith	3M	Dec-96
5,670,559	Primer solution composition for dental bonding	Sun Medical	May-95
5,621,143	Organoborane polyoxyalkylenepolyamine complexes and adhesive compositions made therewith	3M	Apr-95
5,616,796	Organoborane polyamine complexes and adhesive composition made therewith	3M	Apr-95
5,610,251	Polymerisable compositions using air-activated latent initiator system of hydrogenated pyridine compound and acid	Loctite	Jun-95
5,587,406	Primer composition and curable composition	Sun Medical	May-95
5,539,070	Polymerizable compositions made with polymerization initiator systems based on organoborane amine complexes	3M	Feb-95
5,530,038	Primer composition and curable composition	Sun Medical	Aug-94
5,523,347	One-part, air-activatable, free-radically polymerizable compositions	Loctite	Dec-93
5,512,527	Initiator systems for initiating the polymerization of ethylenically unsaturated compounds and use thereof	Henkel	Jul-94
5,461,124	Reactive systems and/or polymer composition for tissue contact with the living body	Henkel	Mar-94
5,459,177	Adhesive for soft tissue and kit thereof	Sun Medical	Mar-94
5,376,746	Acrylic adhesive composition and organoboron initiator system	National Starch	Oct-93
5,310,835	Transparent two-part acrylic adhesive composition and the method of use thereof	National Starch	Sep-93
5,286,821	Acrylic adhesive composition and organoboron initiator system	National Starch	Mar-92
5,143,884	Acrylic adhesive composition and organoboron initiator system	National Starch	Dec-91
5,106,928	Acrylic adhesive composition and organoboron initiator system	National Starch	Apr-91
4,921,921	Meltable aerobically cured plastic compositions	Henkel	May-86
4,676,858	Organoboron containing mixtures and their manufacture and use	Henkel	Jun-85
4,626,310	Surgical adhesive systems for hard body tissues	Henkel	May-85