

Enabling Technology For On-Demand Bonding Of Paper & Paperboard Products

By Jonathan M. Gorbald, Vice-President, CODACO Inc.

WHAT IF you could pre-apply bonding material to your products, and then instantly activate the bond later on, whenever you're ready?

Introduction

The new CODACO High Speed RF Bonding System provides a technically robust, environmentally responsible solution to a problem facing manufacturers whose products incorporate paper or paperboard substrates. The existing adhesives used to bond these materials are generally either water or solvent-based glues which require extensive set-up and dry time, or hot melts which have a limited amount of “open” time to complete the assembly process before the adhesive cools and sets.

The manufacturing challenge has therefore been to physically separate the process of applying adhesive to these substrates from the actual process of bonding them together. With the CODACO System, manufacturers can pre-apply a tack-free adhesive to paper or paperboard substrates, freely manipulate the substrates in complex assembly processes, and later rapidly activate the adhesive from within the bond line with RF energy. Similarly, one layer of a paper or paperboard web can be pre-applied with CODACO adhesive material for later, on-demand adhesive bonding to other substrate layers.

All of this is accomplished with environmentally friendly, water-dispersable adhesives and clean, efficient radio frequency (RF) energy. Manufacturers will benefit from increased productivity and greater design latitude in their products, while consumers will benefit from improved product features delivered by technologically empowered manufacturers.

System Components

The CODACO Bonding System (patented and patents pending) consists of RF-susceptible adhesive materials that can be activated in an RF field along with the corresponding RF-activating equipment. The activating equipment includes a solid state power supply and a process/field probe that quickly delivers the RF energy to the adhesive material at line speeds of up to 1000 ft./min. The system, which was developed by CODACO Inc. in conjunction with Battelle, recently received the prestigious R&D 100 Award for significant technological advancement.

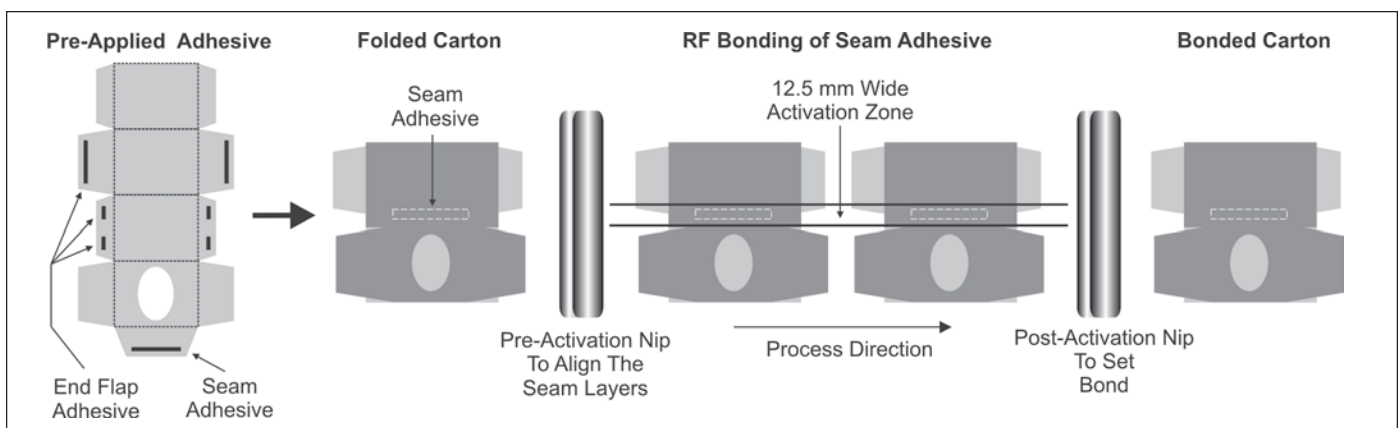


Figure 1: RF Bonding of a manufacturer's glue seam on a folded carton

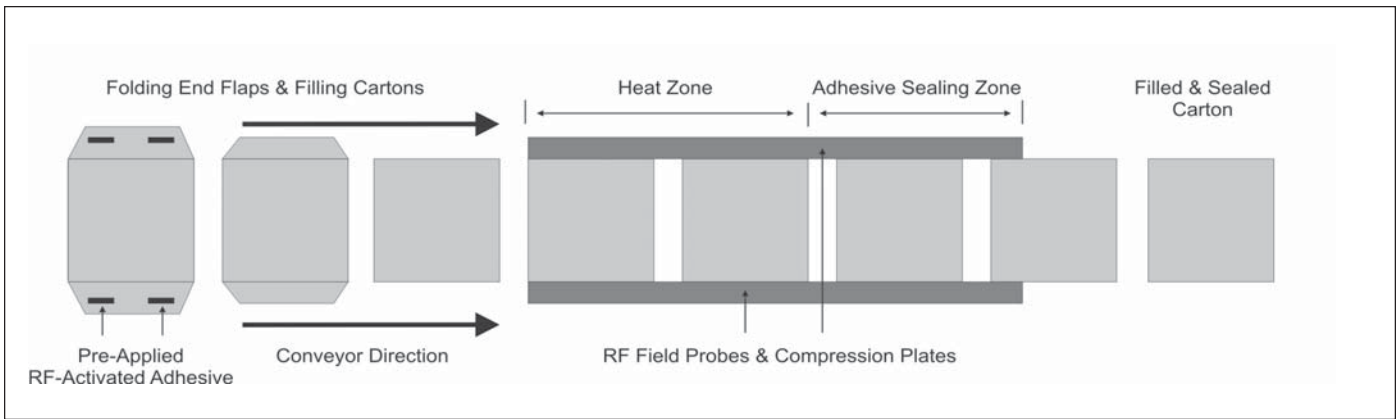


Figure 2: RF bonding of folding carton end flaps

The most important advantage of the CODACO Bonding System is its bond-on-demand capability, which separates the application of the bonding material from the actual bonding process. Two other important advantages are its high-speed activation time and the strength of the bond produced. Repeated laboratory testing has shown that this bond is generally stronger than the substrate itself; as illustrated in Figure 4, the substrate rips or tears under stress while the bond remains intact. A fourth important advantage is the ability to heat the adhesive from within the assembly; manufacturers can utilize higher temperatures and/or faster heat cycles without distorting or damaging the outer assembly layers.

blown patterns. When formulated as a water-borne coating, the adhesive is applied with gravure-type printing systems and dried with RF- or IR-type dryers. In either case, the resulting coatings are light-colored and nearly invisible on the surface of the substrate. The coatings are also dry and tack-free, and do not produce a bond until “activated” by RF energy. This allows the coated substrates to be further handled in subsequent operations, on-line or entirely off-line at the substrate supplier. The user may block, stack or roll the substrate and store/ship the material with the adhesive in place, ready for on-demand activation/assembly at a later date.

Separating Application From Activation

Application

The CODACO adhesive material is pre-applied to the substrate as either a hot melt or water-borne coating with conventional application equipment. In hot melt form, the adhesive is applied as a slot coat or bead, in spiral or melt

Activation

The activation system produces an electromagnetic field which generates heat within the RF adhesive material layer. The adhesive materials are formulated to rapidly absorb and convert RF energy into heat; the properties of the formulation are activated with increased temperature only while the composition is in the electromagnetic field. Activation time is less than 200 milliseconds and the “open” time is controllable. Once removed from the field,

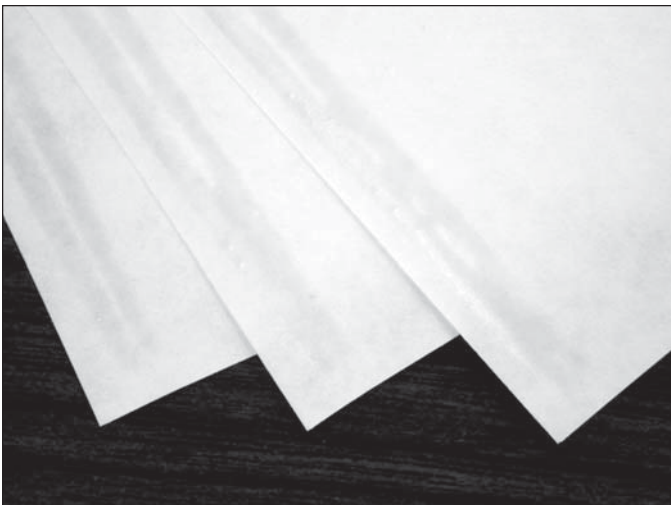


Figure 3: Bonding material pre-applied to paper

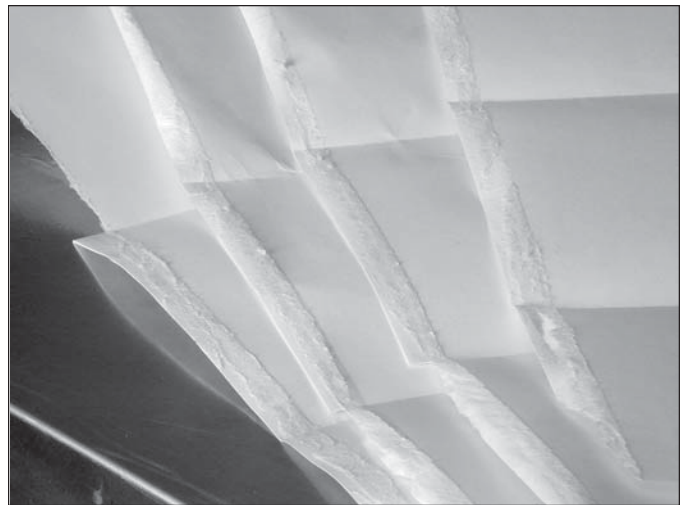


Figure 4: The CODACO bond is stronger than the substrate itself.

“The most important advantage of the CODACO System is its bond-on-demand capability, which separates the application of the bonding material from the actual bonding process.”

the cure rate to green tack is less than 1 second. Selective activation can be achieved through probe design or pattern printing of the composition.

When the materials (with pre-applied adhesive) are ready for bonding, they are passed through the probe assembly, which delivers RF energy from the power supply. Advanced technology within the power supply precisely controls the energy delivery. As a result of combined material and technology advances, the RF energy specifically targets and rapidly activates the adhesive coatings to produce the desired bonds, without significantly interacting with the surrounding layers. Other non-conductive elements will not be heated during the activation process.

In addition to meeting the technical requirements of high-speed, on-demand activation and material-selective bonding, the CODACO Bonding System is people- and environment-friendly. The RF-activating materials are water-dispersable for re-pulping and recycling of disposable products.

Technology Summary

Bonding Materials

- ❖ Can be formulated from a variety of different polymers to suit the customer’s individual application: water-based, hot melt or thermoset adhesive
- ❖ A non-metallic polymeric material, activated by RF energy
- ❖ Can be applied on-line, or pre-applied off-line for on-demand activation up to one year after application
- ❖ Can be tack-free after application to permit re-rolling and re-packaging of substrate
- ❖ Clear, non-descript appearance for transparent use in consumer products
- ❖ Contain no particulate additives, so machine wear is not an issue
- ❖ Applicable to non-metallic materials such as paperboard or paper
- ❖ Can be formulated for application as a hot melt, aqueous spray, pattern print or co-extrusion
- ❖ Hot melts can be reactivated to allow reclaiming or reworking of the bonded materials
- ❖ Very fast activation times (<200 milliseconds) with controllable open time

Ionomeric polymers with polar carriers provide materials that respond rapidly to RF electromagnetic fields. Materials can

be formulated from a range of different polymers and polar carriers to create adhesives, coatings and sealants that can be activated on-demand. Thermoplastic compositions have been formulated from sulphonated polyesters, ethylene-acrylic acid copolymers, vinyl acetate-acrylic acid copolymers and gelatins. Polar carriers such as water, glycerin, ethylene glycol, PEG 200, 400, hexylene glycol and NMP provide effective solutions for different applications. Thermoset compositions have been formulated from epoxy resins, acrylic systems, polyester resins and urethanes.

Activation Systems

Activation systems are available for laboratory use or for full production bonding. Laboratory systems with 1kW output are designed for one-up, single use. The production bonding systems are designed for step and repeat or continuous bonding with cycle times of less than 2 seconds, and continuous web systems at speeds of up to 1000 ft./min. with power levels of 2 or 4 kW.



Figure 5: The CODACO Laboratory Activation System

An activation system consists of an RF power supply and a field/process probe:

RF Power Supply

- ❖ 100% solid state RF power & control circuitry
- ❖ Up to 4 kW deliverable RF power
- ❖ Frequency agile from 10 to 15 MHz, 27.12 MHz +/- 130 kHz, or 57 to 62 MHz
- ❖ Automatic, continuous frequency tuning
- ❖ Supplied by Ameritherm Inc., USA
- ❖ CE marked for all applicable safety and EMC emission standards

Process/Field Probe

- ❖ Delivers an RF field to activate the adhesive material
- ❖ Provides non-contact energy transfer
- ❖ Flexible design, shapes the field to activate specific area(s) (selective bonding)
- ❖ Recessed into a pressure plate to precisely locate the substrate and bond line in the electromagnetic field
- ❖ Generates electromagnetic field on only one side of the substrate
- ❖ Can be configured to activate stationary material or material traveling at line speeds up to 1000 ft/min.

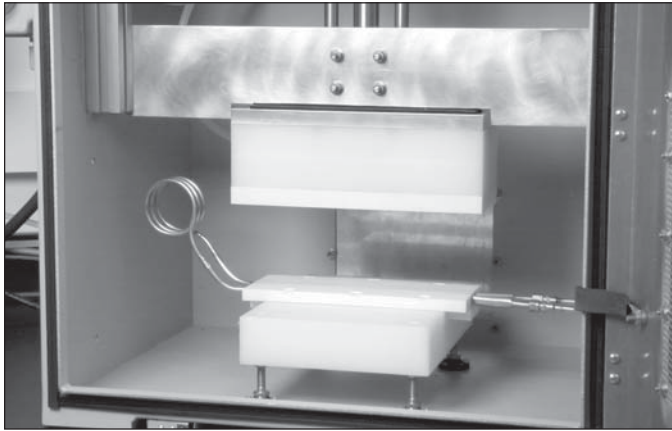


Figure 6: Process/Field Probe for laboratory system

Applications

Initial applications for this technology include the bonding of a variety of paper and paperboard products:

Consumer products packaging

On-demand bonding of selected layers of paper or paperboard products in multilayer assemblies at speeds up to 1000 ft./min. Other potential applications include

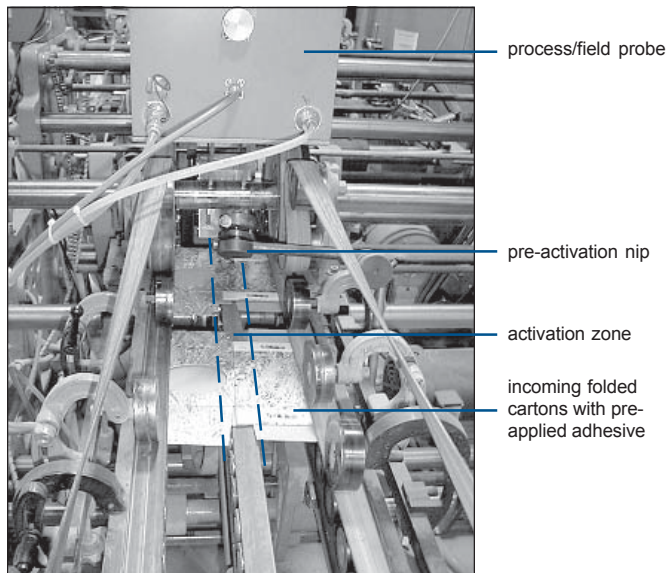


Figure 7: Feed view, folded carton production line

book binding, labels/signs/decals, and composite food and beverage containers.

Other applications for the CODACO system include fusion bonding or sealing of polyethylene and polypropylene substrates, interior and exterior automotive trim, automotive component assembly, laminates for the building and transportation industry, fabric bonding and flexible packaging materials.

Conclusion

The CODACO Bonding System offers several unique advantages to manufacturers who work with paper or paperboard substrates: the ability to separate the adhesive application process from the actual bonding process, very fast activation time, increased bond strength and the ability to heat from within the assembly. The adaptation of this new system leads to increased manufacturing productivity, greater product design latitude and improved product performance.

Both manufacturers and consumers derive long-range environmental benefits. The system's utilization of solvent-free, water-dispersible adhesives and clean, efficient RF energy has a very positive environmental impact. Significant cost reductions will be realized by the elimination of systems required to handle conventional, solvent-based materials.

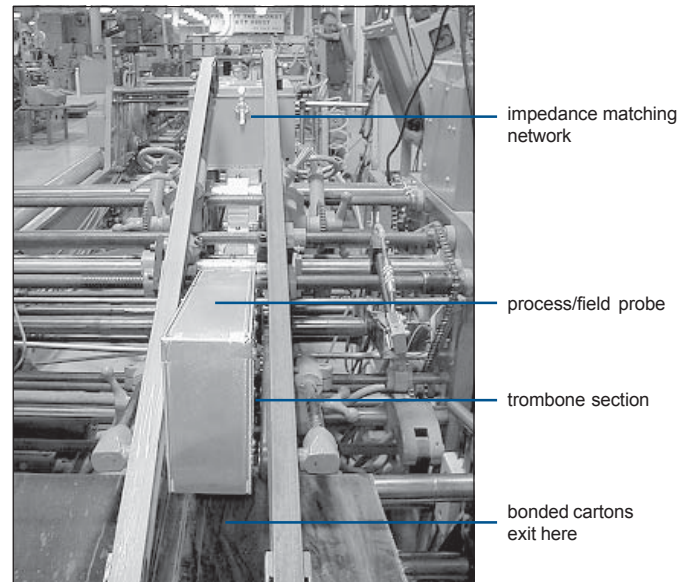


Figure 8: Exit view, folded carton production line

CODACO's ability to create and deliver unique application solutions using its proprietary RF systems has opened the door to positive paradigm shifts in advanced bonding technologies. The CODACO On-Demand Bonding System has the potential to dramatically improve manufacturing assembly processes and consumer product value.