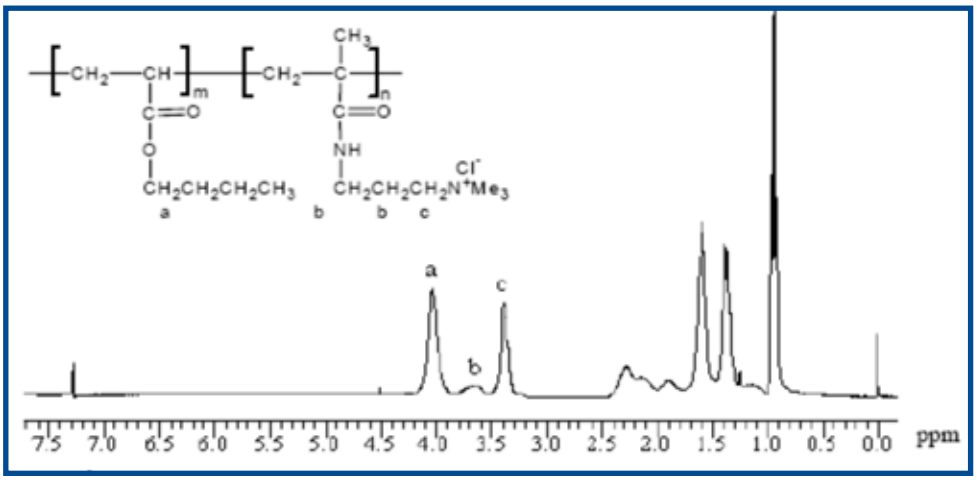
Synthesis, Characterization, and Application of Water-Soluble and Easily Removable Pressure Sensitive Adhesives

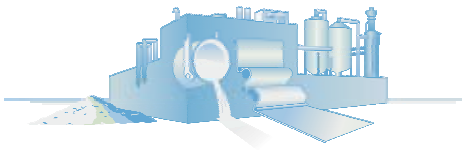
New Adhesives Will Remove the Problem of "Stickies"

Although the pressure sensitive adhesives (PSAs) currently on the market have many applications, they are often deposited as "stickies" on machinery and paper when recycled paper is used as feedstock to produce new paper and paperboard. An adhesive that could be easily removed from recycled paper fiber would save the industry millions of dollars annually by reduced machine downtime and loss of product from current formulations.

The new pressure sensitive adhesives are soluble in water and cationically charged and can be removed from the pulp by adsorption onto fiber and fines. Successful development of repulpable pressure sensitive adhesives will significantly improve paper recycling operations as well as paper manufacturing. Greater understanding of the colloidal properties of adhesive particles in the pulping process is also of interest to both adhesive and paper manufacturers.



Chemical structure and spectral profile of a copolymer used to produce novel pressure sensitive adhesives.



Benefits for Our Industry and Our Nation

- Decrease in capital costs
- Water solubility of the adhesives
- Cost savings from reduced equipment problems
- Environmental benefits from eliminating solid waste and improving paper-recycling operations
- Reduction in energy use

Applications in Our Nation's Industry

The paper-recycling and papermaking industries will benefit greatly from the elimination of the "stickies" problem in its operations. Industrial adoption of this new technology has the potential for higher efficiency and lower capital and energy costs.

Project Description

Goal: To develop a water-soluble pressure sensitive adhesive that has good bonding strength and high stability, will not accumulate in water, and is re-pulpable.

The objectives of the research were to 1) synthesize and characterize water-soluble and easily removable cationic PSAs; 2) optimize the PSA formulation for labels and examine its operational properties (e.g., open time, viscosity, softening and melting temperatures), and end-use properties (e.g., peel strength and shear strength); 3) study the colloidal properties and solubility of PSAs in water under different conditions; this will include studies of the adsorption of colloidal or soluble pressure sensitive adhesives on fiber surfaces; 4) study the repulpability of novel PSAs under laboratory conditions, and optimize the repulping conditions; and 5) study the effects of water soluble adhesives on the fiber and paper properties (strength and sizing).

Results

- Cationic monomers can be copolymerized into polyacrylate using both solvent polymerization and miniemulsion polymerization. The resulting polyacrylate can be formulated to create pressure sensitive adhesives with excellent end-use properties.
- The cationic PSA is water-soluble or dispersible if the cationic content is higher than 10 mol%. However, if the cationic content is too high (>20%), the glass transition temperature of the PSA increases resulting in the decrease of the tackiness and the peel strength of the PSA.
- The water-soluble or dispersible cationic PSAs will adsorb to fibers and be removed from pulp furnish during the papermaking process. Therefore, they will not cause stickies problem on a paper machine.
- 95% of dispersed/water-soluble PSAs will adsorb on fiber surfaces even after 15 cycles of white water use.
- The adsorption of soluble/dispersible PSAs on wood fibers will not affect fiber properties.
- The cost of novel PSA is about 3% higher than current commercially available PSA. However, the PSA developed in this study is recyclable.

Commercialization

A patent application for the technology was filed in July 2000.

Project Partners

Institute of Paper Science and Technology
Atlanta, GA

Georgia Institute of Technology
Atlanta, GA

University of Georgia
Athens, GA

Lions Adhesives Inc.
Lansing, MI

For additional information, please contact

Drew Ronneberg, Ph.D.
Industrial Technologies Program
Phone: (202) 586-0205
Fax: (202) 586-9234
E-mail: Drew.Ronneberg@ee.doe.gov

Yulin Deng, Ph.D.
Institute of Paper Science and Technology
Phone: (404) 894-5759
Fax: (404) 894-4778
E-mail: Yulin.Deng@ipst.edu

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

January 2007
Project completed by February 2003
Full award # DE-FC36-99GO10379