AN OVERVIEW OF THE TECHNOLOGIES FOR ADHESIVE DEBONDING ON COMMAND

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ABSTRACT

Adhesive bonding has found applications in various areas from high technology industries such as aeronautics, aerospace, electronics, and automotive to traditional industries such as construction, sports and packaging. Adhesives can be used to join metals, polymers, ceramics, cork, rubber, and combinations of any of these materials. The use of adhesive bonding rather than mechanical fasteners offers the potential for reduced weight and cost. However, one of the drawback is its "permanence" character as the joints are not easy to disassembly. In most of the cases, structural adhesive joints cannot be disassembled without destroying the substrates. Nowadays, the widely used new materials (i.e. ceramics, carbon fibre reinforced polymers (CFRP), etc.) are usually expensive which create an increasing demand for recyclability, driven by economic as well as environmental reasons. Thus, the development of new technologies and processes for easy recycle and repair of bonded structures are becoming of great interest for the industry. If bonds can be broken without damage of the components, recycling is easier. Also for an environmental friendly disassembly of bonded structures, it is necessary to separate the joint between the bonded components so that the different materials can be reused on a qualitatively high level. As recycling becomes a necessary and global issue, reversible adhesives or debonding on command of the adhesive joints might become a basic requisite for disassembly and recycling in the future. This paper provides an overview of the recent developments in the use of debonding technologies and summarizes the different strategies and approaches to obtain adhesive debonding on command. The use of thermally expandable particles (TEPs), additives and nanoparticles in adhesive debonding are discussed. The use of thermally reversible Diels-Alder chemistry into epoxy resins and electrically induced debonding of adhesives are also presented.

KEYWORDS: Adhesive, Thermally expandable particles (TEPs), Nanoparticles, Additives.

REFERENCES

[1]. **Banea, M.D. and L.F.M. da Silva**, *Adhesively bonded joints in composite materials: an overview*. Proceedings of the Institution of Mechanical Engineers Part L-Journal of Materials-Design and Applications, vol. 223, no. 1, pp. 1-18, 2009.
[2]. **Banea M.D., da Silva L.F.M., Campilho R.D.S.G., Sato C**., *Smart Adhesive Joints: An Overview of Recent Developments*, Journal of Adhesion, vol. 90, no. 1, pp. 16-40, 2013.
[3]. Concil Directive (EC) 2000/53/EC of the European Parliament & Council, on ELV, 2000.
[4].**Morehouse, D.S.J. and R.J. Tetreault**, *Expansible thermoplastic polymer particles containing volatile fluid foaming agent and method of foaming the same*. 1971, US Patent 3615972.
[5]. Matsumoto Yushi-Seiyaku Co., http://www.mtmtys.co.jp, 2013.
[6]. Expancel Home page. http://www.akzonobel.com/expancel/, 2013.
[7]. **Tomalino, M. and G. Bianchini**, *Heat-expandable microspheres for car protection production*. Progress in Organic Coatings, vol. 32(1–4), pp. 17-24, 1997.
[8]. **Andersson, L. and L. Bergström**, Gas-filled microspheres as an expandable sacrificial template for direct casting of complex-shaped macroporous ceramics. Journal of the European Ceramic Society, vol. 28, no. 15, pp. 2815-2821, 2008.

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[9]. **Sakurai, H. et al.,***Evaluation of adhesive properties of elastomeric adhesive. The development and utilization of the removable adhesive*. Bulletin of Shizuoka Industrial Technology Research Center, vol. 43, pp. 11-16, 1998.
[10]. **Ishikawa, H., et al.,***Bond strength and disbonding behavior of elastomer and emulsion-type dismantlable adhesives used for building materials*. International Journal of Adhesion and Adhesives, vol. 25, no. 3, pp. 193-199, 2005.
[11**]. Nishiyama, Y., et al**., *Dismantlement behavior and strength of dismantlable adhesive including thermally expansive particles*. International Journal of Adhesion and Adhesives, vol. 23, no. 5, pp. 377-382, 2003.
[12]. **Nishiyama, Y. and C. Sato**, *Behavior of dismantlable adhesives including thermally expansive microcapsules*, in Adhesion – Current research and application, W. Possart, Editor. 2005, Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim.
[13]. **Kishi, H., et al**., *Design of dismantlable structural adhesives with high temperature performance*. J. of the Adhesion Society of Japan, vol. 42, no. 9, pp. 356-363, 2006.
[14]. **Kim, D., I. Chung, and G. Kim**, *Dismantlement studies of dismantlable polyurethane adhesive by controlling thermal property.* Journal of Adhesion Science and Technology, pp. 1-19, 2012.
[15]. Rescoll Home page and http://rescoll.fr/, 2013.
[16]. **Alcorta, J., M. Olive, and E. Papon**, *INDAR: INnovative dismantling adhesives research.* JEC Composites Magazine, vol. 45, no. 40, pp. 65-66, 2008.
[17]. **Kirsten, C.,***Process for adhesive separation of bonded joints*. 2008, Henkel KGAa (Duesseldorf, DE) US patent no. 7407704.
[18]. **Kolbe, J., et al.,***Curable bonded assemblies capable of being dissociated*. 2009, Degussa AG (Duesseldorf, DE), Fraunhofer-GesellschaftzurFoerderung der AngewandtenForschung E.V. (Munich, DE): United States.
[19]. **Aubert, J.H. and P.S. Sawyer**, *Thermally removable adhesive bonds*. Assembly, vol. 46, no. 2, pp. 46-48, 2003.
[20]. **Aubert, J.H**., *Thermally removable epoxy adhesives incorporating thermally reversible Diels-Alder adducts*. Journal of Adhesion, vol. 79, no. 6, pp. 609-616, 2003.
[21]. **Haydon, D.W**., *ElectRelease - Electrically disbonding epoxy adhesive*. Assembly Automation, vol. 22, no. 4, pp. 326-329, 2002.
[22]. **Leijonmarck, S., et al**., *Electrochemical Characterization of Electrically Induced Adhesive Debonding*. Journal of the Electrochemical Society, vol.158, no.10, pp. P109-P114, 2011.
[23]. **Leijonmarck, S., et al.,***Electrolytically assisted debonding of adhesives: An experimental investigation.* International Journal of Adhesion and Adhesives, vol. 32, pp. 39-45, 2012.
[24].ElectRelease™ Homepage. http://www.eiclabs.com/ERhome.htm, 2013.
[25]. **Norberg P., et al**., *An electrochemically weakable adhesive and a laminate structure*. 2008, WO/2008/150227.
[26]. **Gilbert, M.D**., *Electrically disbonding materials.* United States EIC Laboratories, Inc. (Norwood, MA, US), US patent no 7968188, 2011.