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Durability of Adhesive Bonds to Benefit from Joint Development

Focus on Applications in Automotive Lightweighting and Consumer Electronics

Michigan State University recently announced a collaboration with Endurica, Bosch, and the Department of Energy. The collaboration aims to develop durability evaluation methods for adhesive joints. Endurica will be responsible for integrating the developed testing and simulation methods with its existing fatigue solvers.

"Adhesive materials often have elastomeric character, and exhibit debonding that can be analyzed via fracture mechanical principles. This means that the Endurica fatigue solvers already address some key issues needed for a successful durability analysis solution for adhesive bonds. But in other aspects, there is fundamental work remaining to be done before a general-purpose solution can be implemented," explains Dr. Will Mars, founder and president of Endurica LLC. "Just as they have done in the past in requiring fatigue analysis of metallic components, OEM's are now moving rapidly towards requiring durability simulations on elastomeric components. This is going to include many adhesive joints also. The addition of methods specialized for analyzing adhesive bond durability is one way that we will keep providing unmatched capabilities."

Roozbeh Dargazany to build predictive model

Information Courtesy of College of Engineering, Michigan State University (https://www.egr.msu.edu)

Keeping it together-- MSU receives $1.5 million to predict damage accumulation in polymeric adhesives

Lightweight materials are essential for boosting the fuel economy of modern automobiles while maintaining safety and performance. A 10 percent reduction in vehicle weight can improve fuel economy by 6 to 8 percent.

Roozbeh Dargazany, an assistant professor of civil engineering at Michigan State University, will use $1.5 million to help in the lightweighting effort by building a one-of-a-kind database to better understand one of the challenges – the corrosion of polymeric adhesives.

"Industry is focused on replacing cast iron and traditional steel components with composites, electrification, and miniaturization as major steps toward the lightweighting of vehicles. Polymeric adhesives also play a major role," Dargazany said.

"While past research used physical experiments to better understand reliability of those adhesives in short term, understanding the reliability of adhesives in the long-term remains a major challenge," he explained. "We will be working to predict the service life of degrading adhesives by creating a computational software to describe damage accumulation."

A team of experts from Bosch Germany and Bosch U.S. will collaborate with Dargazany to build the unique database focused on corrosion and reliability analysis of adhesive joints. Funding is provided by the U.S. Department of Energy, Robert Bosch LLC, and Endurica LLC.

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Dargazany said the research is extremely relevant in electronics since the tools of daily life are increasingly made by dissimilar materials that are held together by polymer adhesives.

“Most electronics, including your cellphone, laptop or even your car CPU, may stop functioning due to unexpected corrosion-induced failure of adhesives used in their electrical or structural components,” Dargazany continued. “In many systems, early failures can have major consequences.”

In the auto industry, reliability of polymeric adhesives to corrosive environments is specifically important in the design of electronics, electro-mechanical modules, and structural components.

“Corrosion of polymeric adhesives in joints is a menace to electronics and structural components of vehicles,” said Emad Poshtan of Bosch’s Division of Automotive Electronics, who oversees the Bosch support on this project. “Damage accumulates from heat, oxidation, radiation, moisture and other sources. Combine that with progressive aging and fatigue, it becomes a reliability issue.”

Dargazany and his Bosch colleagues have proposed a new hybrid modeling technique that could help engineers monitor the aging specialized adhesives as they are exposed to corrosion due to water, heat, and sunlight.

Dargazany said the observed corrosion is a sign of continuous degradation at the atomic and molecular levels. “In modeling degradation, you have to understand how different factors such as UV, temperature or moisture change the rate of degradation at the micro-scale. In extreme conditions, adding these factors to fatigue loading can reduce the service-life of the samples from decades to days.

“Our data-driven approach will allow models of different corrosion and fatigue mechanisms to be integrated into one platform. We hope to predict the service life of degrading adhesives to begin solving this issue.”

Endurica President William Mars noted that one of the key challenges in vehicle lightweighting, especially for polymeric adhesive interfaces, is achieving adequate durability.

“The ability to accurately test and simulate the performance of such adhesive interfaces under realistic service conditions will drive many new opportunities for these materials in demanding applications,” Mars said.

Dargazany’s research is supported by a 2018 Energy Efficiency and Renewable Energy Award from the U.S. Department of Energy and project collaborators at Robert Bosch Corp., a tier-1 supplier of technology and service, and Endurica, a provider of simulation software for durability and endurance of elastomeric components.

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Endurica LLC provides pre-prototype solutions for developers seeking durability in elastomer applications. Endurica is focused on durability and elastomers, and has developed the world’s first numerical fatigue life solver for elastomers. Our solver is used to predict fatigue life based on the results of Finite Element Analysis. Our solutions include software, characterization services, testing instruments, and training for engineers and analysts. The company was founded in 2008. (www.endurica.com)

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