

CALCE Finds Toyota Tin Whiskers a 'Significant' Threat

Written by Mike Buetow

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COLUMBIA, MD -- Researchers at the **University of Maryland's** Center for Advanced Life Cycle Engineering have independently found tin whiskers in

Toyota

vehicles with potentiometer type accelerator pedal position sensors (APPSs).

The studied pedals furthermore have been shown to cause shorts known to spur sudden unintended acceleration.

For their study, CALCE researchers Bhanu Sood, Michael Osterman and Michael Pecht performed a physical analysis of an engine control system from a 2005 Camry XLE and an accelerator pedal assembly from a defunct 2002 Camry. The 2005 engine control system included the ECM, an accelerator pedal unit, throttle body, electrical connectors and electrical connecting cables. The paper overviews the analyses and focuses on the discovery of tin whiskers found in the accelerator pedal assembly, which are an electrical failure concern.

The researchers used analytical techniques such as x-ray fluorescence (XRF), scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) to present a construction analysis of the APPS.

They found that use of a tin finish in the APPS is "a cause for concern." Tin finishes are known to produce metal whiskers that are conductive and capable of creating unintended current leakage paths. In the analysis, a "significant number of tin whiskers" were found.

The results were published in the [latest issue of Circuit World \(paid subscription required\)](#).

The teardown found tin whisker formations in in both vehicles. (It was not known if the tin whiskers was associated with any malfunctions during the life of either car.) "We were looking at the overall manufacturing of assembly circuit and looking for what level of construction had the potential for defects throughout the entire engine control system," says Osterman, senior research scientist and the director of the CALCE Electronic Products and System Consortium.

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CALCE's analysis supported earlier findings by **NASA** of the presence of tin whiskers in the APPSs of multiple Camrys. But while the **National Highway Traffic Safety Administration** issued a report exonerating Toyota, CALCE found as many as six tin whiskers growing on one APPS, and concluded "the potential for a tin whisker shorting failure was 140/1 million. Considering the number of vehicles on the road, it is expected that this would present a significant safety hazard."

The CALCE researchers also found the potential for tin whiskers in the ECM, stating, "The ECM contains surface mount electronic devices connected with tin-lead solder to a multilayer PCB. ... Interconnect terminals of the perimeter leaded devices were found to be plated with tin. In addition, tin plating was found on terminal pins of the edge connections. As previously discussed, tin-finished leads can grow tin whiskers which can lead to unintended electrical shorts."

"We know whiskers can form on tin finished terminals," Osterman said. "In this case, Toyota has tin plating in a rather sensitive area, where the system relies on changes in resistance to provide a signal for acceleration."

That runs counter to the NHSTA report. On Feb. 8, Department of Transportation Secretary Ray LaHood released

Technical Assessment of Toyota Electronic Throttle Control (ETC) Systems

and

Technical Support to the National Highway Traffic Safety Administration on the Reported Toyota Motor Corporation Unintended Acceleration Investigation

. The two reports, LaHood said, exonerated Toyota's electronics as the alleged cause of unintended acceleration complaints: "The verdict is in," LaHood said. "There is no electronic-based cause for unintended, high-speed acceleration in Toyotas."

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In their discussion about the printed circuit board manufacturing processes of Toyota Camrys, CALCE scientists questioned the lack of a safety standard regarding automotive electronics, given broad range of whisker-induced failures. They also took the NHTSA to task for its published findings, noting, "It is highly likely that tin whiskers could induce a failure that is later undetected. For this reason, best practices for electronics design stipulate that tin not be used as a plating material. It is very questionable why the National Highway Traffic Safety Administration, with a stated mission to 'save lives, prevent injuries and reduce economic costs due to road traffic crashes, through education, research, safety standards, and enforcement activity,' has not come out with a requirement that no electronics use pure tin as a material component, since the potential for tin whiskers presents an unreasonable and unnecessary risk."

Other researchers, including [automotive watchdog](#) [Safety Research & Strategies](#), [have also taken issue](#) with the NHTSA and NASA findings.