

## Fairfield, Ohio inventor receives first Ohio Patent Award

*Invention required hundreds of trials to find right formula to bond metal to rubber.*

A patented method of treating metal to bond better with rubber has garnered Prof. William Vanooij and colleagues of ECOSIL Technologies LLC of Fairfield, Ohio the first Ohio Patent Award from **The Ohio Academy of Science** and **The Ohio State Bar Association Intellectual Property Law Section**. The award also recognizes their attorney, Martin J. Miller of Cincinnati.

The invention uses silanes—a class of chemicals that contains the element silicon—as a coupling agent to bond two otherwise non-bonding and incompatible surfaces. Cooper Tire & Rubber in Findlay, Ohio has successfully tested the chemical on the steel cords in their tire belts to improve the performance of radial tires.

Prof. Vanooij said that his research goal with silanes to bond rubber to metals was to find a process that could replace the brass coating on the steel cords in radial tires because brass technology has several drawbacks, one of which is that brass-coated steel is sensitive to corrosion. “Further,” he said, “the exact formulation of the natural rubber in the tire, which is optimized for adhesion, makes that rubber sensitive to heat aging, the underlying cause of the tires failed by tread separation that one can sometimes observe along US highways, especially in the summer.”

Vanooij said that the search for a brass coating replacement at the University of Cincinnati, where at the time he was a Professor in Materials Science, did not quickly identify the silanes he and his students used.

“We had to try almost 100 different silanes before after about two years we accidentally stumbled on a particular mixture of two silanes that worked perfectly,” he remarked.

“An important finding was that this mixture works with many different rubber types and formulations and with a wide range of metals. Thus, the applicability of the process is much greater than in tires only. It works only in a certain ratio of the two silanes, but it outperforms the currently used brass coating in tires in terms of aging resistance and corrosion protection of the steel filaments,” he continued.

Ohio has a rich history of innovation including the controlled, powered airplane, the automobile self-starter, the flip-top can, the vaccine for feline leukemia, and numerous other patented inventions that have had a worldwide impact.

A panel of five members from the Academy’s Board of Trustees and the Intellectual Property Law Section of OSBA, evaluated 11 applicants for the patent award based on several criteria that included the following: (a) most prolific (greatest number) of patents in a year, or (b) a patent which has significantly impacted the state of Ohio through positive changes measured by economic, social change,



*Academy President-Elect, Prof. Terry Keiser (L) and Prof. William J. Vanooij*

health benefits, growth of new industries, jobs, or other possible criteria. The attorney associated with the winning patent also will receive the attorney award.

The inventor received an engraved plaque at the Academy’s annual meeting on April 10 at Ohio Northern University, Ada. Martin J. Miller, the attorney of record for the patent, also received an engraved plaque at the Academy’s annual meeting.

Further details are posted at [www.ohiosci.org/PatentAward.pdf](http://www.ohiosci.org/PatentAward.pdf). Email questions to [oas@iwaynet.net](mailto:oas@iwaynet.net) or call 614.488.2228.

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### Rubber-to-Metal Bonding by Silanes

USP 6,416,869; July 2, 2002; Van Ooij, Jayaseelan and Mee

#### Patent Abstract

**A method of treating a metal substrate by applying a coating of a silane composition having at least one substantially unhydrolyzed aminosilane having one or more secondary or tertiary amino groups. Methods of adhering a polymer (such as rubber) to a metal substrate are also provided.**

Dutch born William J. Vanooij (known prior to 2009 as Wim J. VAN Ooij), since 2009 a naturalized citizen of the United States, is inventor on 30 US patents, 16 outstanding US patent applications, 38 EP patents and 4 JP patents, in addition to many patents in several other countries. The highest number of his US patents issued in one year was three in 1994, 1995 and 2002.

USP 6,416,869, issued on July 2, 2002 and assigned to the University of Cincinnati, was selected for competition for the 2010 Ohio Patent Award. Co-inventors with Prof. Vanooij were Senthil Jayaseelan, then a graduate student under his guidance at the University, and the late Eric Mee, an engineer at SENCO, Inc., a private business in Cincinnati. Attorney Martin J. Miller, who helped develop the patent, was then with Dinsmore & Shohl, Cincinnati and currently has his own practice, Martin J. Miller LLC in Cincinnati OH. This patent has two divisional patents, 6,560,079 and 6,919,469, issued in 2004 and 2005, respectively.

This patent describes a process for forming a strong bond between a non-vulcanized rubber mixture and a metal during the vulcanization of the rubber in contact with the metal at elevated temperature and pressure in a mold. A thin film of a silane mixture coats the metal prior to the vulcanization process. A silane is a liquid chemical which contains the element silicon. There are hundreds of silanes commercially available. They differ in the composition and structure of the molecule other than the silicon part. Silanes, commonly known as “coupling agents”, can bond metal and ceramics (such as glass) to adhesives and paints. Silanes are environmentally safe to handle and are not known to be toxic.

This invention is significant for two reasons. First of all, when the research that led to the patentable invention was started in the late nineties, there were no silanes known in the public or patent literature that could bond natural rubber to metals, despite their use as coupling agents in other applications. Natural rubber is the rubber type used, for instance, in radial tire belts. In such tires a strong bond is formed between the steel cords that form the belt and the layer of natural rubber used in the belt region of the tire. This bond develops during the vulcanization of the tire in a mold. Other (synthetic) rubber types cannot be used there, for a variety of reasons. The strong and durable bond develops as a result of the presence of a thin coating of brass (an alloy of copper and zinc) that is plated on all the filaments of the steel cords. The aim of his research with silanes for bonding rubber to metals was to find a silane process that could replace the brass coating on the steel cords, as the brass technology has several drawbacks, one of which is that brass-coated steel is sensitive to corrosion. Further, the exact formulation of the natural rubber in the tire makes that rubber sensitive to heat aging. Although simplified, this is the underlying cause of the tires failed by tread separation that one can observe along US highways, especially in the summer.

The search for a brass coating replacement at the University of Cincinnati, where he was a Professor in Materials Science, did not quickly identify useful silanes. His research team tried almost 100 different silanes over two years before they accidentally stumbled on a particular mixture of two silanes that worked perfectly. That mixture is described in USP 6,416,869. It works only in a certain ratio of the two si-

lanes, but it outperforms the currently used brass coating in tires in terms of aging resistance and corrosion protection of the steel filaments. An important finding was that this mixture works with many different rubber types and formulations and with a wide range of metals. Thus, the applicability of the process is much greater than in tires only.

The second reason why this patent is important is that it has eventually led to a joint program between Cooper Tires (Findlay, OH), one of their steel cord suppliers (Tokusen in Conway, AR) and ECOSIL Technologies LLC (Fairfield, OH) in which radial tires were designed and built with the steel cords coated with the silane mixture of the invention. Other joint patents have been filed, with one allowed so far, on the actual method of applying the silane on the cords, which is far from trivial. Cooper has recently tested tires using this method that that confirmed the high expectations of improved performance. Thus, this invention can create new jobs, maintain existing ones and will make radial tires even better than they already are.



*The Ohio Academy of Science*  
and



**The Ohio State Bar Association  
Intellectual Property Law Section**

**OHIO PATENT AWARD**

See [www.ohiosci.org/PatentAward.pdf](http://www.ohiosci.org/PatentAward.pdf)

#### **Purpose**

**T**HE PURPOSE OF THE OHIO ACADEMY OF Science/Ohio State Bar Association Intellectual Property Law Section Patent Award is to recognize individuals or organizations and their counsel who have contributed new intellectual property in the form of a granted patent within the geographical state of Ohio. Ohio has a rich history of innovation including the controlled, powered airplane, the automobile self starter, the flip top can, the vaccine for feline leukemia, and numerous other patented inventions which have had a worldwide impact. The award will also recognize the attorney who has helped to develop and prosecute the patent.