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CASE STUDY

# EP21TDCS: Used to Secure Wire Leads to the Terminals of a Thermal-Sprayed Strain Sensor

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## Overview of EP21TDCS

Master Bond EP21TDCS is a two-component, silver-filled, electrically conductive epoxy adhesive designed for high-performance bonding, sealing, and coating applications. Its excellent electrical conductivity and strong bonding to metals make it well-suited for attaching wire leads to steel substrates coated with a nickel alloy.

## Application

Engineering systems are prone to failure due to material degradation and complex stress interactions, but conventional damage detection methods often lack integrated, real-time monitoring capabilities. To address this, researchers at the University of Alberta and the University of Toronto developed bilayer thermal-sprayed, piezoresistive nickel alloy (NiCoCrAlTaY) coatings as integrable strain sensors. This approach offers better durability and the potential to overcome the limitations of traditional strain gauges while enabling real-time monitoring of structural health. As part of this design, the authors applied EP21TDCS at the terminals of the conductive NiCoCrAlTaY layer, where wire leads were attached before curing.

## Key Parameters and Requirements

The authors used flame spraying to deposit coatings with tunable compositions to adjust their resistivity and durability, which are required for strain sensing. The authors sequentially deposited an $Al_2O_3$ insulating layer to prevent electrical shorting with the A36 steel substrate, and then a conductive NiCoCrAlTaY-$TiO_2$ layer as the sensing element. The authors investigated two different compositions for the NiCoCrAlTaY-$TiO_2$ conductive layer: one with 20 wt% and one with 40 wt% $TiO_2$.

Once the conductive layer was deposited, the authors applied EP21TDCS at the terminals, to which wire leads were attached (**Figure 1**). Then, EP21TDCS was cured and served as an electrical interface between the deposited sensing layer and external measurement circuitry, enabling stable electrical connections required for monitoring resistance changes in the coating while the samples underwent repeated mechanical loading.

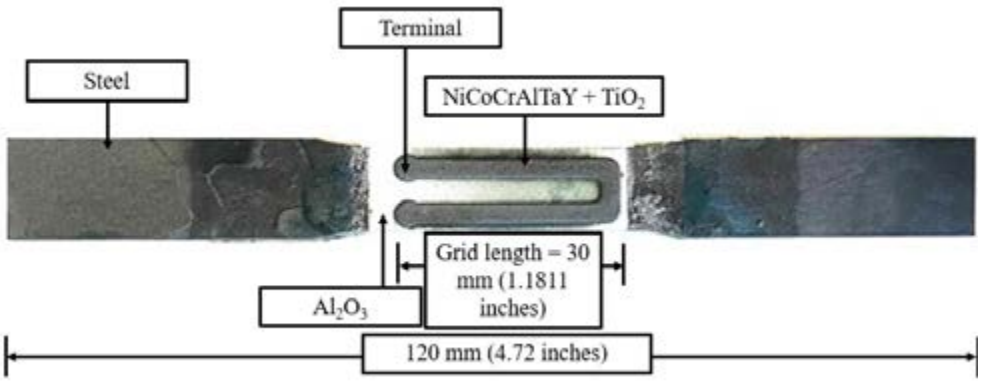


*Figure 1. Steel sample after depositing a bilayer coating with $Al_2O_3$ as an insulating layer and NiCoCrAlTaY-$TiO_2$ as an electrically conductive layer. EP21TDCS was used to attach wire leads to the terminals.*

## Results

The authors investigated two different compositions of NiCoCrAlTaY-$TiO_2$, with one containing 20 wt% $TiO_2$ and another containing 40 wt% $TiO_2$. During electromechanical tests, the system underwent extension and compression cycles to generate strain cycles ranging from -1000 µm to +2000 µm. The 40 wt.% $TiO_2$ composition showed more stable electrical behavior (**Figure 2**), likely due to enhanced mechanical properties, despite minor changes attributed to microstructural evolution during cycling.

The electrical conductivity and strong adhesion of EP21TDCS allowed the attached leads to transmit accurate voltage signals without detachment or contact degradation during cyclic strain testing, supporting reliable measurement of the coating's piezoresistive response.

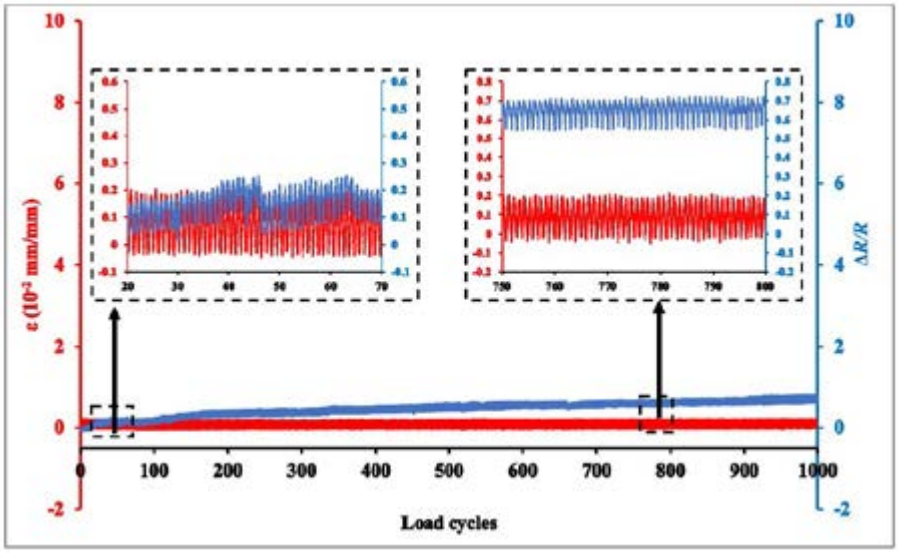


*Figure 2. Electromechanical plot of the bi-layered coating-substrate with NiCoCrAlTaY- 40wt.% $TiO_2$ as the conductive layer.*

## Conclusions

This study demonstrated that thermal-sprayed NiCoCrAlTaY-$TiO_2$ coatings can function as durable, sensitive strain sensors with stable electromechanical performance under repeated loading. EP21TDCS was used to attach wire leads to the NiCoCrAlTaY-$TiO_2$ layer and ensured reliable electrical connections over 1000 cyclic extension and compression cycles, supporting its use in advanced sensing systems for integrated structural health monitoring.

## Reference

Ogunbadejo, A. S., Jarligo, M. O., Chandra, S., McDonald, A., Flame Sprayed NiCoCrAlTaY-TiO2 Coatings as Structural Health Monitoring Sensors. http://dx.doi.org/10.2139/ssrn.4715917