Vibration analysis of electrical connector under different environments

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Abstract. An electrical automotive connector was composed of a female part and a male part subject to the vibrations of the vehicle, which could cause relative movements between these two parts. A relative movement of the contact zone between these two parts can lead to an irreversible mechanical degradation and an electrical perturbation by the formation of a third-body layer at the contact zone. Our study was about the dynamic measurement of electrical behavior of metallic connectors under imposed alternate movement with sinusoidal form.

Introduction

In the automotive fields, the vehicle vibrations induce movement on hundreds of connectors, which were located near the engine, inside the seat and at many other zones. The engine vibrations could induce a displacement between the male and female part i.e. the pin and the clip (Fig.1) and could generate an electrical failure due to the well-known fretting-corrosion phenomenon. A relative displacement of 5 µm was enough to produce remains at the interface between the pin and the clip and set an intermittent failure at the interface. This phenomenon represents 60 % of electrical failure within a car. Electrical contacts were made of a substrate of copper alloy plated with a thin protective layer of non-noble metals. Tin was usually used as a protective layer of the substrate in order to combine a good conductivity, good reliability and a low cost. A pure tin was malleable and reacts with the oxygen to give hard and brittle remains, which cause high surface damages. The substrate could be reach and it generates copper oxide remains at the contact surface leading to an irreversible degradation, which avoids a good current conduction [1-2].

Results and discussion

The aim of this work was to give further information to understand the oxygen influence on the current conduction of a tin-plated contact and oxidized remains. An experimental bench was used to introduce an inert gas at the interface of a tin-plated connector in order to avoid the formation of insulating remains due to the oxygen of the air. The nitrogen gas was chosen during the tests; it was chemically inert for the tin and the copper and it represents 79 % of the atmosphere. Samples were typical terminals of connector. The bench was composed of a piezo-electric actuator, which provides a controlled movement between the clip and the pin (Fig.1). A generator provides a stable current through the interface and the measurements of contact voltage were performed with a voltmeter and a scope for a real-time analysis. The bench was mounted on an anti-vibration table in order to avoid external vibrations. The imposed alternate movement has a sinusoidal form.
The displacement of different parts of the used connector decreases when frequency increases (Fig.2). A resonance frequency was observed at 205 Hz for the pin, the clip and the clip holder. The displacements of the clip and the clip holder (inserted into the sample holder) are 1.5 µm greater than the actuator displacement. This result indicates the fixing of the clip and the clip holder to the sample holder needs to be examined. The study will also shows the importance of the environment, the amplitude and the frequency.

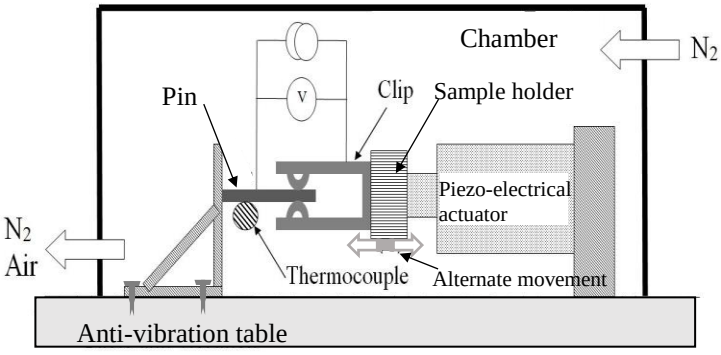

Figure 1: Schematization of vibration setup: Controlled movement supplied by piezo-electrical actuator

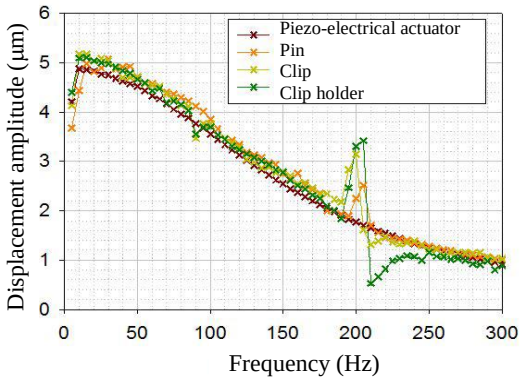

Figure 2: Displacement versus vibration frequency

References

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[2] Labbe J., El Abdi R., Carvou E., Le Strat F. and Plouzeau C. (2014) Vibration induced at contact point of tighten-up connector system. *IEEE Holm Conference on Electrical Contacts* 200-204.