Distributed Fiber Optic Sensing: Strain Measurements on Powder Coated Metal

Contents

Introduction

Powder coating is a method for electrostatically binding dry powder onto surfaces. This creates a surface finish that is harder and tougher than conventional paint. While providing better protection for surfaces, this tough finish makes it difficult and time consuming to sand off when preparing the surface for strain sensor bonding. The ability to obtain accurate strain measurements from fiber sensors bonded directly to powder coated test articles can save time and money. This engineering note compares strain measurements taken from fiber sensors bonded onto a bare stainless steel surface to those on a powder coated stainless steel surface.

Test Setup

A thermoset powder coat 3-5 mils thick was applied to the unmasked half of a stainless steel coupon (1½" x 3/16" x 12"; Figure 1). A low bend loss polyimide-coated fiber optic strain sensor was bonded to both the powder-coated and bare surface of the coupon. Four passes of fiber were bonded as shown schematically in Figure 1.

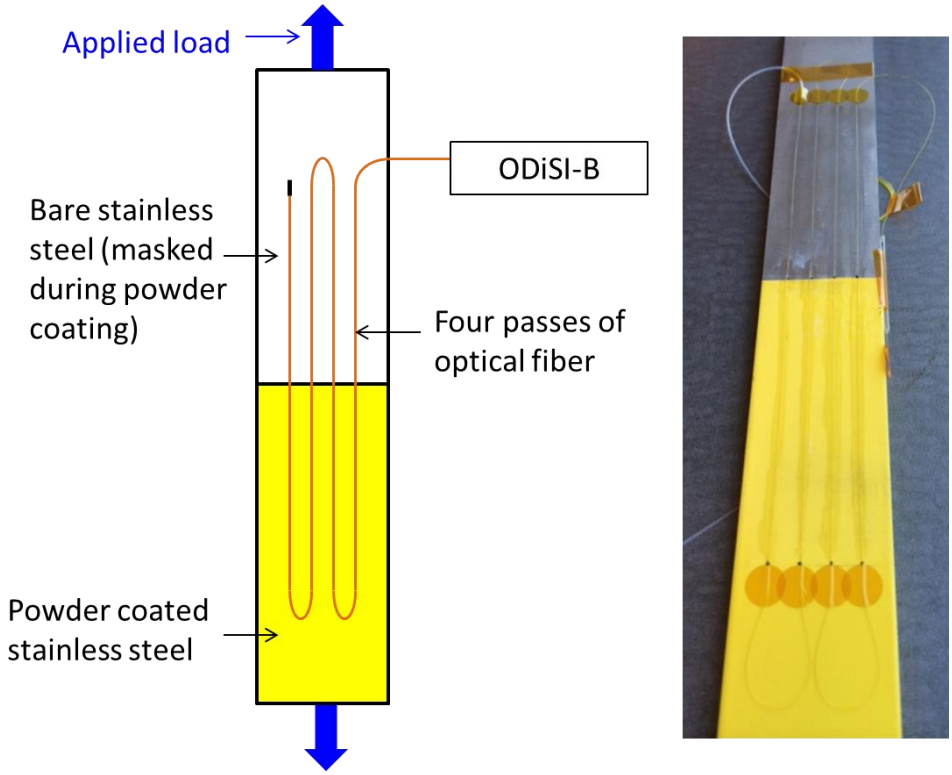

Figure 1: Diagram and image of Stainless Steel coupon

The instrumented coupon was tested in an MTS load frame. Load was applied in steps of 1000 lb up to 5000 lb, corresponding to strain increments of approximately 125 με. This loading cycle was repeated six times. Strain data was taken with an ODiSI-B in high resolution mode – 1.25 mm gage length with 1.25 mm sensor spacing at an acquisition rate of 23.8 Hz.

Results

Figure 2 shows strain along the length of the fiber at maximum load. The strain levels of each fiber pass are slightly different due to MTS grip misalignment that could not be corrected. However, within each fiber pass, there is visually no difference between measurements obtained from bare steel (blue) compared to powder-coated steel (red).

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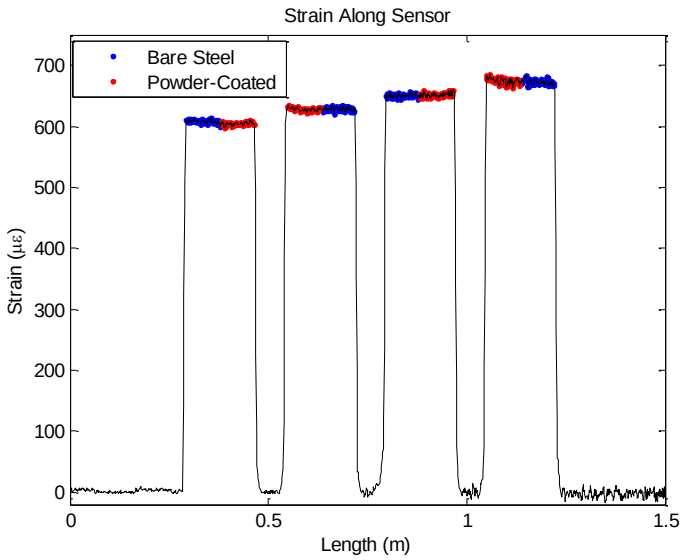

Figure 2: Plot of strain along sensor length

The correlation of strain measurements from the two surfaces is further shown in Figure 3 below. A plot of strain from the powder coated metal against strain from the bare metal follows a linear fit (R^2=1), with a slope of 0.996. This slight difference is within the repeatability specification of the ODiSI-B (± 5 με).

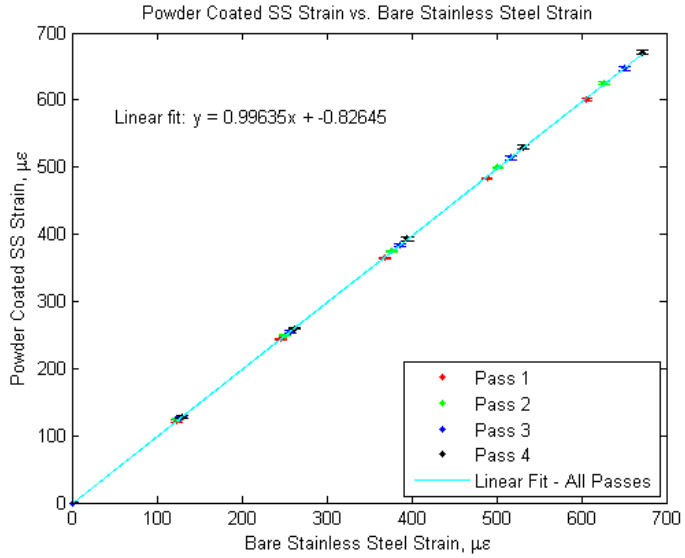

Figure 3: Plot of strain on powder coated stainless steel against bare stainless steel

Summary

Fiber optic sensors can be bonded directly onto well adhered powder coated surfaces. This results in accurate strain measurements, within the repeatability specification of the ODiSI-B. The accompanying time and financial savings would be very beneficial when carrying out strain measurement tests.

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