A Novel Crack Detection Methodology for Green-State Powder Metallurgy Compacts using an Array Sensor Electrostatic Testing Approach

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ABSTRACT

This paper briefly reviews a new instrumentation approach developed for the electric resistivity testing of green-state P/M compacts. Rapid testing of the green-state specimens is made possible through a special-purpose sensor configuration, which incorporates a matrix of 10 by 10 spring-loaded needle contacts with pin spacings of 0.1 inches. The sensor permits the detection of hairline flaws with surface openings as small as 20 microns.
A quantitative analysis of defect resolution is conducted to lay the foundations for the experimental and validation phase of the sensor development. In particular, a dipole model representation for flaws embedded in the compact is proposed. Further, by incorporating Gaussian random noise to the voltage recordings, measurement uncertainties can be explored. This model is utilized to investigate the depth a flaw can be detected based on a given signal-to-noise ratio of the instrument.

Key words: Non-destructive evaluation, resistivity instrumentation, testing of green-state compacts, theoretical dipole modeling, sub-surface flaw detection.

BACKGROUND

In response to industrial quality assurance demands, an inexpensive, on-line nondestructive evaluation (NDE) instrument has been developed to inspect P/M compacts early in the manufacturing process when the samples are still in their green-state prior to sintering. This project was funded through the PMRC consortium partners and CPMT. As recent research has shown [1-4], electric resistivity testing is perhaps the most suitable NDE technique to inspect these green-state compacts. The relatively high electric resistivity, or conversely speaking low conductivity, of the metallurgical structures permits the creation of substantial electric field distributions inside and on the surface of the samples in response to an applied current. The resulting voltage patterns established on the surface carry sufficient information to detect both surface-breaking and sub-surface defects [5]. The system consists of a multitude of spring-loaded probes to contact the sample; DC current is injected through two of the probes, and voltages are measured using an array of probes that cover the entire surface area of the part. A flaw in the