Applied Research Activities

Innovative Eddy-current testing based on GMR sensor arrays for characterization of complex-shaped components

Clemens Voigt[1], Dr. Mykola Vinnichenko[1], Dr. Marco Fritsch[1], Martin Schulze[1], Dr. Peter Krüger[1], Dr. Gilbert Santiago Canon Bermudez[2], Dr. Yevhen Zabila[2], Dr. Denys Makarov[2]

[1]Fraunhofer IKTS, Dresden; [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden

Clemens.Voigt@ikts.fraunhofer.de

Eddy-current testing is versatile non-destructive characterization method of electrically conductive materials including carbon-fiber-reinforced polymers (CFRP), which are increasingly prevalent in designing lightweight complex-shaped components. Present work deals with validation of the technological steps critical for realization of the novel mechanically flexible eddy current probe concept using GMR sensor arrays. The GMR sensors were prepared by magnetron sputtering onto PET and PI substrates by depositing nm-thick Co/Cu layers, which were showing the GMR effect up to 12 %. Reproducible manufacturing up to 100 sensor structures was demonstrated. This effect did not change substantially neither after static bending to the 4 mm radius nor after cycling bending tests (6000 cycles from 40 mm to 8 mm and reverse). The sensors were contacted using combination of inkjet printing with high power diode laser array post-processing on millisecond time scale. This enabled realization of highly conductive (conductivity factor 2 higher compared to the structures after furnace treatment at 100 °C for 4 h) flexible silver-based interconnects to read-out electronics without causing degradation of the GMR sensors beneath and without damaging thermally sensitive polymer substrates. Validation of this technological step substantially increases design freedom of the flexible eddy current probes and has a potential to enable their cost efficient manufacturing due to roll-to-roll compatibility of these methods. Further, a folding technology of the simplified flexible probe was tested to realize the physically necessary positioning of the GMR elements with respect to the bias and measurement magnetic fields without complex joining procedures for test objects with radii up to 100 mm. A heterodyne detection method for demanding sensor environments (elimination of external interference fields in harsh industrial environments) was validated. Finally, the functionality of the deposited GMR sensors on practice-relevant reference defect structures was demonstrated.