Impact of Testing Probe on Identification of Fatigue Cracks in Nondestructive Inspection of Biomaterials

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Abstract **The paper deals with impact of various testing probes on eddy current signals in non-destructive evaluation of conductive biomaterials. The biomaterial samples with presence of fatigue cracks will be inspected under the same conditions. Paramagnetic biomaterials with defined electric and magnetic properties will be inspected. Gained results will be discussed and presented in the full-paper.**

Keywords **Non-destructive evaluation, eddy current testing, conductive biomaterial, crack identification.**

I. Introduction

Non-destructive evaluation of biomaterials is based on numerous physical principles and phenomena. Eddy current testing (ECT) is one of the widely utilized electromagnetic NDE methods. ECT works based on an interaction of time-varying electromagnetic field with a conductive structure according to the Faraday's electromagnetic induction law. There are many advantages such as high sensitivity for surface breaking defects, high inspection speed, contact-less inspection, versatility of the ECT mainly in biomedical and strategy industries. ECT instruments provide raw data with limited or absent capability of interpreting quantitatively the data. They can detect an anomaly but they are usually unable to find its shape and dimensions [1]. Typically, evaluation relies on calibrated curves measured on pre-fabricated etalons and on the skills of an operator. However, the progress in powerful computers has allowed developing of automated procedures to make decisions. Common eddy current probes are designed in such a way that they sense the perturbation field only in one direction. Usually the most significant component of the perturbation field is picked-up and consecutively used for the evaluation. However, curved paths of eddy currents provide more information in principle.

Biomaterials are materials that interact with biological systems. They are often used or adapted for a medical application, and thus comprise whole or part of a living structure or biomedical device which performs, augments, or replaces a natural function. One of the primary reasons that biomaterials are used is to physically replace hard or soft tissues that have become damaged or destroyed through some pathological process. Although the tissues and structures of the body perform for an extended period of time in most people, they do suffer from a variety of destructive processes, including fracture, infection, and cancer that cause pain, disfigurement, or loss of function. Under these circumstances, it may be possible to remove the diseased tissue and replace it with some suitable synthetic material. One of the most prominent application areas for biomaterials is for orthopedic implant devices. Both osteoarthritis and rheumatoid arthritis affect the structure of freely movable (synovial) joints, such as the hip, knee, shoulder, ankle, and elbow. As a class of materials, conductive biomaterials are the most widely used for load-bearing implants. For instance, some of the most common orthopedic surgeries involve the implantation of metallic implants. These range from simple wires and screws to fracture fixation plates and total joint prostheses (artificial joints) for hips, knees, shoulders, ankles, and so on, [2], [3], [4]. In addition to orthopedics, metallic implants are used in maxillofacial surgery, cardiovascular surgery, and as dental materials. Although many metals and alloys are used for medical device applications, the most commonly employed are austenitic stainless steels, commercially pure titanium and titanium alloys, and cobalt-base alloys.

II. Experimental Set-up

The article will present the utilization of the non-commercial ECT probes as the excitation/sensing elements for the inspection of biomaterials, Fig.1. The harmonic excitation signal will be used to drive the probes. The study will be aimed to show that the information value of the biomaterial fatigue crack eddy current signals is influenced by the probes with different properties (air probe, probe with core, and probe with various shielding).

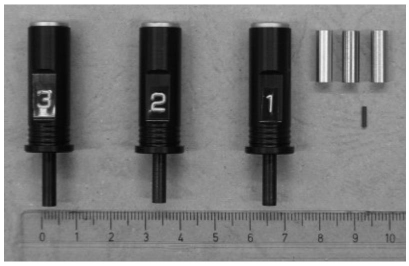

Fig. 1. Eddy current probes used for the inspection

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