Fraunhofer IKTS

European Commission

PhD position

Residual Stress measurement of aero-engine materials with nonlinear Ultrasound and Electromagnetic techniques

The advertised post is funded by the Marie Skłodowska Curie Action within the framework of the Innovative Training Network scheme H2020-MSCA-ITN-2016. The duration of the fixed-term contract is 36 months and the earliest starting date is **February 2017**.

The "NDTonAIR" consortium involves Universities, Research Organisations and major European companies working on new Non-Destructive Testing (NDT) and Structural Health Monitoring (SHM) techniques for aerospace. The goal is to train a new generation of scientists and engineers with a wide background of theoretical and experimental skills, capable of developing their research and entrepreneurial activities both in academy and industry and playing an active role in promoting the importance of quality inspection and structural monitoring in aerospace components. For more details also see: www.ndtonair.eu.

Objectives:
During their lifetime, aero-engine components are subject to extreme circumstances in terms of temperature and stress, imposing very stringent requirements on their durability. Measuring the residual stress (RS) profile in components can play a crucial role for maintaining them in operation and to evaluate the durability of parts. Starting from earlier results of Fraunhofer[1,2] and Newcastle[3,4], the measurement procedures of the RS of surface treated aero-engine alloys by Rayleigh wave velocity dispersion measurements and magnetic methods will be developed and compared. The UT method relies on the knowledge of the third order elastic constants (TOEC), usually unknown for the treated material. One of the projects key challenges will be the determination of those material constants at the specimens itself in the near surface region. Nonlinear ultrasound measurements with Rayleigh type waves will be developed to get this information. In contrast, the optimal EM method depends on the magnetic properties of the inspected sample so different techniques will be used and compared. Developing the relation between macro- and microstructure, the RS and the EM properties is another key challenge of the project.

[1] B. Köhler, et al. "Characterization of surface treated aero engine alloys by Rayleigh wave velocity dispersion" AIP Conference Proceedings 1211, 253-260 (2010)
[2] M. Barth, et al. "Universal ultrasonic goniometer for Rayleigh and surface skimming longitudinal wave dispersion measurements" AIP Conference Proceedings 1430, 1873 (2012).
[3] P. Wang, et. al "Investigation of temperature effect of stress detection based on Barkhausen noise" Sensors and Actuators A: Physical 194, 232-239 (2013);
[4] M Morozov, et al. Noncontact evaluation of the dependency of electrical conductivity on stress for various Al alloys as a function of plastic deformation and annealing" Journal of Applied Physics 108 (2), 024909, (2008)

Expected Results:

- Development and machining of a set of test specimens with high residual surface stress and low microstructure change (cold work)
- Development of a method for the determination of the acoustic nonlinearity parameter and the TOEC in situ (directly at the surface treated regions) by nonlinear ultrasound measurements
- Evaluation of existing methods for Rayleigh wave dispersion measurements (laser vibrometry, goniometry) for the set of samples and applicability of inversion schemes (to get the stress and the elastic property gradient)
- Correlation between elasto-plastic state of metallic components (stress states, material parameters) and their electromagnetic NDT responses
- Comparison and evaluation of EM and UT NDT methods for material characterization

The position includes planned secondments to the University of Newcastle Upon Tyne (UK), Kauno Technologijos Universitetas (Lithuania), and Siemens AG (Germany). The candidate will take part in scientific training courses for "fundamental skills for NDT" and in complementary skill training courses in "Technology Transfer and Entrepreneurial in NDT".

The successful candidate must:

- be in the first four years (full-time equivalent research experience) of her/his research career, since e.g. completion of her/his master's degree,
- not already possess a doctorate degree,
- not have resided or carried out his/her main activity (work, studies etc.) in Germany for more than 12 months in the 3 years immediately prior to the time of recruitment.

Relevant Qualification & Experience:

- M.Sc. / Diploma in Engineering or Physics
- Practical experience with ultrasound and electromagnetic NDT
- Basic understanding of nonlinear ultrasound and corresponding measurements
- Programming and data evaluation experience (LabView and/or Matlab)

Communication and Interpersonal Skills:

- Very good organisational skills
- Willingness to undertake interdisciplinary research
- Willingness for secondments at project partners
- Fluent in written and spoken English and/or German

Benefits:

Living allowance EUR 3 072.00 per month + mobility allowance: EUR 600.00 per month (contribution to household, relocation and personal travel expenses), family allowance: EUR 500.00 per month (for fellows who have family at the time of recruitment, i.e. persons linked to the fellow by marriage or a relationship with equivalent status or dependent children who are actually being maintained by the fellow)

Candidates interested in the position should **send their applications via e-mail** to:

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