B2B-MEETINGS

„Meet the experts"

Wednesday, 25th September 2019

at 4th Workshop on Laser-Ultrasound for Metals

PROFILE CATALOGUE

This catalogue portraits selected **experts** that can be **booked for face-to-face meetings** on the first day of the conference. Please have a look at all the expert profiles and let us know with whom you would like to have a conversation.

Send your **list of preferred experts** to een@biz-up.at **until September 19th**. You can choose a **maximum of 4 experts** for the B2B-meetings. Please indicate first the experts with highest priority for you and select quickly because the meetings will be booked according to the "first come first serve" principle! You will receive your **personal time schedule** in due time before the event.

The meetings will take place on Wednesday, **25th of September** between **04:00 – 05:30 p.m.** at the location of the event. You will have 15 minutes per conversation. Our staff will be at your disposal in case you need assistance and support.

The B2B-Meetings are organized by the Enterprise Europe Network (EEN) together with RECENDT. The EEN is the world's largest support network and is co-financed by the European Commission. It helps businesses and research organisations to find international cooperation partners. Each EEN office worldwide is responsible to support the clients in its region. **With the participation in the B2B-meetings you agree that we will inform the respective EEN office in your region so that they can offer you EEN-support and follow up the meetings.**

Contact
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Expert profiles

#1	**Felix Brand,** Germany Coburg University of Applied Sciences and Arts	Characterization of aluminium oxide layers with a laser ultrasonic setup using the dispersion of Rayleigh waves
#2	**Tomáš Grabec,** Czech Republic Czech Academy of Sciences	Numerical modelling of acoustic-wave scattering in polycrystalline media
#3	**Sandra Megahed,** Germany RWTH Aachen University	Hybrid Tooling using Laser Powder Bed Fusion: Possible applications for Laser Ultrasound
#4	**Marc Choquet** PhD, Canada Tecnar	Non-contact laser-ultrasonics evaluation
#5	**Mikael Malmström,** Sweden Swerim AB	Comparative study of structures in annealed 304 stainless steel using laser-ultrasonics (LUS) in combination with EBSD and XRD
#6	**Bruno Pouet,** USA Sound & Bright	The Quartet Receiver, ideal for Industrial Integration
#7	**Martin Ryzy,** Austria RECENDT	Measurement of effective surface acoustic wave attenuation in polycrystalline aluminum
#8	**Norbert Huber,** Austria RECENDT	Robot aided LUS for joints and welds
#9	**Clemens Grünsteidl,** Austria RECENDT	Using zero-group-velocity Lamb waves to determine thickness and bulk sound velocities of isotropic plates
#10	**Mike Hettich,** Austria RECENDT	Metal film adhesion in heterogeneous layer systems

Institut für Sensor- und Aktortechnik

Expert #1:

Felix Brand

Coburg University of Applied Sciences and Arts, Germany
ISAT - Institute of Sensor- and Actuator Technology
www.isat-coburg.de

ISAT's portfolio ranges from technology research for industrial applications with high specific requirements through sensor selection, optimization and integration to the development of individual sensor/actuator solutions adapted to the respective industrial requirements. The institute focuses on three main topics:

- Microacoustics
- Microoptics
- Microfluidics

Topic presented at LUS4Metals:

Characterization of aluminium oxide layers with a laser ultrasonic setup using the dispersion of Rayleigh waves

Quality assurance in the metalworking industry includes the testing of near surface layers and material parameters. Most common test methods are destructive, either because cuts have to be made or because of chemical attack.

In this study a measuring instrument for non-destructive and non-contact testing and characterization of near-surface layers and depth-dependent material parameters is presented.

For this purpose, a laser ultrasonic setup was realized using a pulsed laser to excite Rayleigh waves and an interferometer with a photorefractive crystal to detect the displacement of the surface caused by the Rayleigh waves. The measured dispersion of the phase velocity is used to deduce the material properties close to the surface.

Aluminium anodised layers being generated by different process parameters are investigated with the device presented. The thickness and hardness of the anodised layers were determined and the results were compared with destructive hardness measurements proving the appropriateness of the method for non-destructive surface layer characterisation.

Expert #2:

Tomáš Grabec

Czech Academy of Sciences, Czech Republic
Department of Ultrasonic Methods - Institute of Thermomechanics
www.it.cas.cz/d5

The laboratory of ultrasonic methods deals with both experimental and theoretical research in the field of mechanics of materials. It is oriented on the utilisation of physical acoustic principles for the evaluation of mechanical properties of metals, intermetallics, ceramics, composites, and functional materials (ferroics) as well as the characterisation of structural changes and material damage. For this purpose the laboratory develops original ultrasonic methods such as resonant ultrasound spectroscopy, acousto-optical methods, etc.

Topic presented at LUS4Metals:

Numerical modelling of acoustic-wave scattering in polycrystalline media

Grain-boundary scattering is the major contribution to acoustic-wave attenuation in polycrystalline materials at ultrasonic frequencies. Analytical models, developed since the 1950s, describe the frequency dependence of the attenuation based on characteristic grain size. Experimental determination of the attenuation is immensely difficult, and it is often not in a good agreement with the analytical models. Hence, numerical modelling, and particularly Time-Domain FEM, plays a vital role in the study of this phenomenon, offering a way of generating a large amount of data. For the simulations, a 3D polycrystalline-like model must be generated. The Laguerre-Voronoi tessellation allows tuning of various statistical properties of the artificial structure in order to mimic given samples.

In recent works, the importance of the two-point correlation function (TPCF) as the function representing the grain morphology was shown. [1] In the standard analytical theories, there is only a general form assumed. However, with the exact TPCF of the considered structure inserted into the Weaver model of attenuation, the analytically and numerically calculated attenuation of longitudinal bulk waves were found to be in a great agreement. As there is no analytical model for surface-wave attenuation, a simple model based on the adapted Weaver model has been constructed. A thorough experimental work using frequency-domain opto-acoustic laboratory setup has shown that the SAW scattering behaves predictively, i.e., similarly to shear waves. [2]

In the present contribution, the simulations of bulk and surface acoustic waves propagating through a tessellated, sample-mimicking structure will be presented, together with their comparison to analytically and experimentally obtained results.

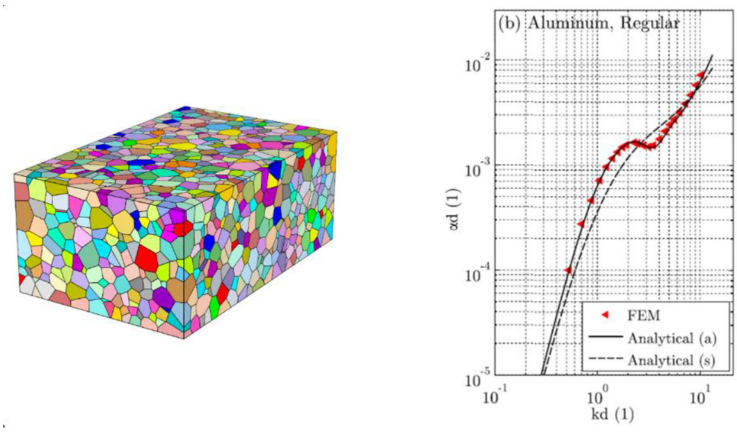

Figure 1: On the left, an example of 3D Laguerre tessellation used as a model of a polycrystalline structure. On the right, comparison of longitudinal bulk wave attenuation for standard and adapted Weaver models and TD-FEM simulation results. [1]

References

[1] M. Ryzy, T. Grabec, P. Sedlak, I.A. Veres, *Influence of grain morphology on ultrasonic wave attenuation in polycrystalline media with statistically equiaxed grains*, JASA 143 **2018**, pp. 219-229

[2] M. Ryzy, T. Grabec, J. Oesterreicher, M. Hettich, I. A. Veres, *Measurement of coherent surface acoustic wave attenuation in polycrystalline aluminum*, AIP Advances 8 **2018**, 125019

Expert #3:

Sandra Megahed

Chair of Digital Additive Production
RWTH Aachen University, Germany
http://www.dap.rwth-aachen.de

The Chair for Digital Additive Production DAP at RWTH Aachen University focuses on the further development of Additive Manufacturing (AM) in a fully networked, digital production environment: From the digital product model, through automated component and powder handling in an AM factory, to the ready-to-use, certified component, all aspects of additive product development are taken into account.

Topic presented at LUS4Metals:

Hybrid Tooling using Laser Powder Bed Fusion: Possible applications for Laser Ultrasound

High Pressure Die Casting (HPDC) tools undergo several repairs during their life cycle. Traditional repair methods (e.g. milling) cannot always be applied necessitating complete tool replacement. Milling removes material from the tool, which can affect the final dimensions of the cast. The removed material has to be replaced. This study investigates Laser Powder Bed Fusion (LPBF) as an alternative route to manufacture and repair HPDC tools. LPBF is an Additive Manufacturing technique in which components are built layer by layer using metal powder. LPBF is chosen due to increased design freedom compared to Laser Metal Deposition.
In order to decrease costs, higher build rates via thicker powder layers are targeted. Suitable process parameters like laser power, scan speed and hatch spacing are optimized to avoid lack of fusion and keyholing porosity. Within this project, the powder layer thickness varies from 30 µm to 90 µm. High density (greater than 99.5 %) is achieved for 60 µm layers, doubling the process speed when compared to 30 µm layer thickness samples.

Samples with 60 µm layer thickness, manufactured without preheating, contain cracks at grain boundaries (i.e. grain boundary cracking), indicating hot cracking initiated during the LPBF process. Therefore preheating is recommended. Building components with preheating and cooling at a controlled rate after the LPBF process can reduce hot cracking. Cold cracking formed after the process due to residual stresses was not found.
Characterizing defect density via Laser Ultrasound (LUS) could greatly speed up sample preparation and analysis and reduce material waste and in turn cost.

Hybrid manufacturing is based on building additively onto a conventionally manufactured HPDC tool. Challenges with the LPBF process include the interface between conventionally processed and additive part, porosity and crack defects as well residual stresses. The microstructure of the interface between conventional and additive part affects mechanical properties and is metallographically analyzed. Grain size and grain orientation are characterized and linked to process parameters. The interface between the conventional and additive tool must withstand the mechanical and thermal loads during the HPDC process. Using LUS to analyze microstructure in terms of grain size can indicate the homogeneity and anisotropy of the component. The analysis of phase transformation by use of LUS could allow for preliminary quantification of mechanical properties.

The repeatability of LPBF processes is a common challenge. Small fluctuations in laser power, scan speed or hatch distance have a significant influence on the final part. With the help of LUS, the repeatability of print jobs can be verified.

In terms of mechanical properties, tensile strength, ductility and hardness are quantified. It is expected that the mechanical properties of the additive part of the component are anisotropic due to the oriented nature of the LPBF process. The hardness is measured in the interface and along the height of the component and correlated to the microstructure, in particular grain size. Since mechanical properties are closely related to microstructure, LUS can also be applied as means of quality control.

Expert #4:

Marc Choquet PhD**,** Canada
Senior Business Development
Tecnar Automation Ltée, Canada
www.tecnar.com
Exhibitor

Tecnar, founded in 1989 develops, manufactures and markets advanced sensors to optimize industrial processes. Over the years, Tecnar's technical expertise and customer service have earned the respect of leaders in the steel, aerospace, power generation and automotive industry. Today, Tecnar sensors routinely operate in more than thirty countries and are distributed in all five continents. We take pride in offering the best manufacturing/engineering warranty in the business so you can rely on Tecnar process control technologies for years to come.

Topic exhibited at LUS4Metals:

Non-contact laser-ultrasonics evaluation

Laser-ultrasonics (LUT) is a non-contact, non-destructive evaluation method that combines the accuracy of ultrasonic technique (UT) with the flexibility of optical systems. LUT is relatively novel method that is, however, currently being used in a broad range of applications, from hot steel thickness gauging, to weld inspection, to in-situ metal texture analysis. Tecnar has develop an expertise in adapting complex technologies, such as LUT, to routine industrial and research use. Our team has been working for more than 20 years in the field of LUT. With our flexible laser-ultrasonics products and our expertise, Tecnar will help you to jump start your application and quickly get results.

With Tecnar's team, you get:

- Unique and innovative technologies
- Industrial point-of-view that focuses not only on getting the data but on how best to use it
- Client-oriented results
- Consistent process intelligence
- 24/7 technical support

Expert #5:

Mikael Malmström

Senior Researcher - Nondestructive Material Characterization
Key expertise: Laser ultrasonics for non-destructive online material characterization for the industry, as well as defect detection in welds and AM parts.
Swerim AB, Sweden
https://www.swerim.se/en

Swerim is a Swedish research institute working with mining, metallurgy and materials. Swerim pursues evidence-based research in close collaboration with industry to promote industrial renewal, improved competitiveness and sustainable growth. In other words, we assist with applied research focusing on your specific needs and problems, providing solutions that can be directly applied in industry. At Swerim specialists cover the following areas of expertise:

- Materials Sciences & Raw Materials
- Materials Production
- Manufacturing Processes
- Production Systems
- Product Engineering
- Energy & Environment

Topic presented at LUS4Metals:

Comparative study of structures in annealed 304 stainless steel using laser-ultrasonics (LUS) in combination with EBSD and XRD

The material investigated was 304 (18/8) stainless steel that had been rolled with 70% at 700°C reduction to a final thickness of 2.9 mm. This warm rolling was chosen to avoid complications due to the formation of deformation martensite at room temperature. A 2.9x30x170 mm strip of the steel was then annealed in a controlled temperature gradient ranging from room temperature up to 1100°C so that all possible microstructural stages were represented, comprising recovery, recrystallisation and grain growth as well as their related texture changes. All measurements were made after cooling the specimen down to room temperature.

Grain sizes were measured by LUS using the b-parameter analysis of attenuation data. In addition, the newly developed method for scanning the generating laser was applied to show the influence of texture on the anisotropy of wave velocities. Thus, both grain size and texture were continuously monitored along the length of the gradient annealed specimen.

X-ray diffraction (XRD) was applied at various positions such that recovery and recrystallisation could be quantified using peak breadth measurements. In addition, microstructures and textures were determined using electron back-scattering diffraction (EBSD) at several locations corresponding to different annealing temperatures.

All the observations were congruent in defining the location where primary recrystallisation had taken place over a relatively short distance on the specimen. The XRD line breadths dropped sharply and then remained constant after higher temperatures. However, the LUS grain sizes which also showed a sharp decrease then increased continuously as grain growth progressed, in good agreement with the EBSD observations. The anisotropic wave velocity results confirmed a significant change in the texture corresponding to recrystallisation despite the fact that EBSD showed that there was, in fact, only a modest weakening. A sensitive parameter defining recrystallisation was found to be the Poisson's ratio which fell sharply and then increased very gradually up to the highest temperatures. This is interpreted as being due to the textural change during recrystallisation, followed by some sharpening of the annealing texture during subsequent grain growth.

Expert #6:

Bruno Pouet

Chief Technical Officer
Sound & Bright, USA
https://www.soundnbright.com/
Exhibitor

Sound & Bright offers a range of cutting-edge laser-based ultrasound systems for Non-Destructive Testing applications ranging from laboratory research and development to industry. Our systems provide market-leading sensitivity and noise reduction. The technologies on which they are based were born of research and development grants from the National Air and Space Agency (NASA) and the National Science Foundation (NSF) and have been continually updated to meet our customer's exacting standards. We are based in Los Angeles, California where our systems are designed and built to order.

Our receivers are hand-assembled and tested by the same experts who developed them. With over ten patents to his name, Sound & Bright's Chief Technical Officer, Dr. Pouet, is one of the leading scientists in his field. Thanks to his research and development we are currently the only company on the market to offer a system based on multi-channel random quadrature (MCRQ), the Quartet, which was developed thanks to grants from NASA and NSF. We continually explore the application of innovative technologies through government or private R&D contracts to enhance the performance of our instruments and develop new inspection techniques.

Topic exhibited at LUS4Metals:

The Quartet Receiver, ideal for Industrial Integration

The Quartet multi-purpose laser receiver is well suited for a wide range of acoustic and ultrasonic applications including rapid scans of complex shapes, laser welding monitoring, on-line inspection, and quality control.
The receiver's patented and proprietary MCRQ technology is not subject to stability issues common to most long cavity and path-stabilized interferometers; it does not require high accuracy optical components or positioning, making it exceptionally rugged. Thanks to its efficient light collection, multiple detectors and streamlined electronic processing, it can perform measurements on any kind of surface, including rough, porous, rusted or mirror-like. The versatile fiberized optical head can be easily mounted to fit a variety of measurement conditions and can be set-up for a wide range of stand-off distances.
These features combine to make the Quartet an ideal receiver for integration in an industrial setting, all while providing high sensitivity, and requiring low to no maintenance.

Expert #7:

Martin Ryzy

RECENDT - Research Center for Non Destructive Testing GmbH, Austria
www.recendt.at

The Research Center for Non Destructive Testing GmbH (RECENDT) provides a range of services which incorporates the whole R&D process chain and stretches from application-oriented fundamental research to the development of state-of-the-art technology for industrial applications. RECENDT implements customized, high-tech solutions in the fields of material characterization and non-destructive materials testing. The interdisciplinary team consists of physicists, chemists, mechatronics engineers, and development engineers with state-of-the-art equipment at their disposal which enables them to contribute to the success of the business in various branches.

Topic presented at LUS4Metals:

Measurement of effective surface acoustic wave attenuation in polycrystalline aluminium

Elastic waves which are propagating in polycrystalline materials are permanently scattered at the boundaries between adjacent grains. This leads to a macroscopic, measurable spatial attenuation in propagation direction, which is related to details of the microstructure (e.g. the mean grain diameter) and thus might be used for its characterization. Here, we present a non-contact, fully laser-based ultrasound setup for the measurement of grain boundary scattering induced coherent surface acoustic wave attenuation in metals. The method seems particularly well suited for the microstructure characterization of thin metal sheets, where bulk wave approaches fail.

Grain boundary scattering of ultrasonic waves in metals has been studied for several decades now. Although many theoretical models for the effective wave attenuation exist, even today their exact experimental validation and their inversion on ultrasound measurements for the mean grain diameter is still a challenging topic. This might have several reasons like experimental imprecisions, improper measurement of an effective attenuation (ensemble average response) and additional assumptions which are usually made about the grain size distributions. Also, usually longitudinal bulk waves are studied which can only be probed at opposite sample faces. Thus, the attenuation coefficient has to be calculated from the wave amplitudes at very few spatial data points along the wave's propagation path, which might lead to inaccuracies.

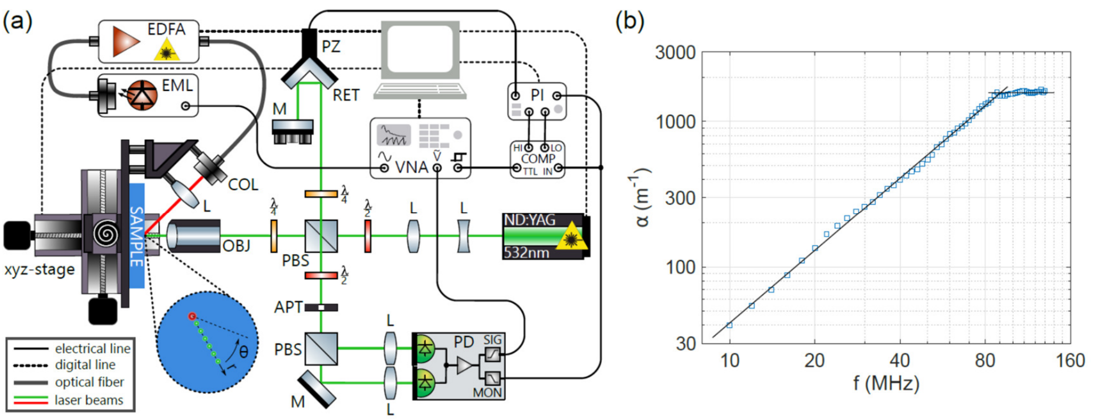

Figure 1 (a) Laser-Ultrasound setup for SAW attenuation measurements. (b) SAW attenuation of an aluminum sample.

Here, we use a fully laser-based frequency domain ultrasound setup (see Fig.1(a)) to excite Rayleigh type surface acoustic waves and to measure their displacement fields in polycrystalline aluminum samples at many points on the sample surface. A spatial scanning scheme is introduced which allows for the subsequent extraction of the effective attenuation coefficient by exponential data fitting. Attenuation curves are obtained in the frequency range from 10 MHz to 130 MHz (see Fig.1(b)) and comparisons to an analytical attenuation model are made. The model calculations are based on the polycrystals' spatial two-point correlation functions which are directly determined from micrographs. Thus, no assumptions about the material's microstructure are necessary. Measurements and calculations are found to be in very good agreement.

RECENDT
RESEARCH CENTER NON DESTRUCTIVE TESTING

Expert #8:

Norbert Huber

RECENDT - Research Center for Non Destructive Testing GmbH, Austria

www.recendt.at

The Research Center for Non Destructive Testing GmbH (RECENDT) provides a range of services which incorporates the whole R&D process chain and stretches from application-oriented fundamental research to the development of state-of-the-art technology for industrial applications. RECENDT implements customized, high-tech solutions in the fields of material characterization and non-destructive materials testing. The interdisciplinary team consists of physicists, chemists, mechatronics engineers, and development engineers with state-of-the-art equipment at their disposal which enables them to contribute to the success of the business in various branches.

Topic presented at LUS4Metals:

Robot aided LUS for joints and welds

Modern products in automotive and metal industry require more and more challenging combinations of complex parts. Spot-, seam- and friction welding of the same or different materials are found in many products. Additionally, gluing is often used as a mechanical link between metal sheets for the automotive industry. And, unnecessary to say, error-free function of each of these joints is essential for the mechanical stability and quality of the final product. But on the other hand the complexity of modern surfaces makes it hard to test these joints with conventional NDT (non-destructive testing) methods.

LUS (Laser Ultrasound) can be one solution for this problem. Results of LUS for different joints will be showed in this talk. Additionally we will present the actual development stage of a new technical approach for a laser based NDT system for fast and contactless testing of complex structures. The LUS-system is based on a non-contact laser ultrasound technique with delivery of both, the laser ultrasound excitation- and detection pulses, through flexible optical fibers. Also the backscattered light is again collected into a fiber. The measurement head, which contains the two beam outputs and the light collection optics, is scanned over the surface by a 6-axis lightweight robot arm. Several systems of excitation and detection lasers can be used. An example of a full system, including excitation- and detection lasers will be presented.

Expert #9:

Clemens Grünsteidl

RECENDT - Research Center for Non Destructive Testing GmbH, Austria
www.recendt.at

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Topic presented at LUS4Metals:

Using zero-group-velocity Lamb waves to determine thickness and bulk sound velocities of isotropic plates

We report on an ultrasound method to simultaneously determine the thickness of an isotropic plate, together with the longitudinal and shear elastic wave velocities of its material. It does not require assumptions or a priori knowledge of the plate thickness or the sound velocities, which are usually required to obtain the other quantity from time-of-flight measurements. Our approach is to measure the frequencies of two zero-group-velocity (ZGV) Lamb modes and one respective wavenumber.

ZGV Lamb waves are resonant waves which appear at multiple defined angular frequencies and wavenumbers k in the Rayleigh-Lamb dispersion spectrum of plates, where the group velocity c_G= d /dk becomes zero. We use this relation, which depends on the elastic properties, the mass density and the thickness of the plate in an inverse problem to obtain the properties of the plate. Experimentally, the frequencies of ZGV points can be obtained at high precision by measuring the elastic response spectrum of a plate, using laser-ultrasound techniques. By shaping the excitation laser spot with a spatial light modulator, we extend this to enable measurements of the corresponding wavenumber.

The research was supported by the strategic economic- and research program "Innovative Upper Austria 2020" of the province of Upper Austria and the Austrian Science Fund (FWF), project number P 26162-N20.

Expert #10:

Mike Hettich

RECENDT - Research Center for Non Destructive Testing GmbH, Austria
www.recendt.at

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Topic presented at LUS4Metals:

Metal film adhesion in heterogeneous layer systems

Time-resolved spectroscopy on short timescales, i.e., in the sub-ns regime, allows to investigate mechanical vibrations of thin films down to a few nanometer thickness where the eigenmode frequencies fall into the GHz to THz range. Close inspection of the vibrational eigenmode lifetimes or acoustic pulse transmission properties yield information about interfaces in stratified systems. Here we will discuss Aluminum and Gold thin films on silicon substrates where the latter were fabricated with varying interface adhesion. We will show the influences of the interface properties on the acoustic eigenmode vibrations and discuss the possibilities to obtain information about the interface adhesion.

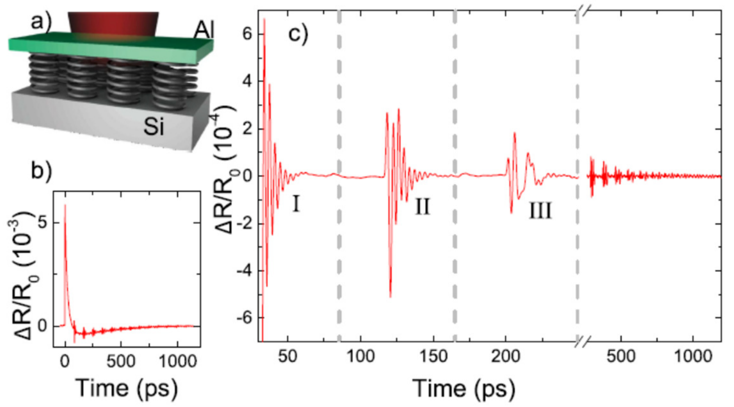

Figure 1: (a) sample sketch (b) time domain trace (c) extracted acoustic sample response, copied from New J. Phys. 19 (2017) 053019