JRP – i20

Metrology for length-scale engineering of materials

Objective

To measure and understand plasticity size effects

To meet the measurement challenges that size effects pose

To realise the material and component performance benefits that length-scale engineering offers

Indentation and uniaxial compression testing methodologies are included and contributions to ISO and EN standards will be made

Need for the project Strength-ABLE:

It is essential that EU companies are provided with length-scale enabled design and modelling capabilities in order that they can maintain their competitiveness.

For more sustainable components with longer life and lower energy use in manufacture and in service

Size-enabled measurement methods and analysis

Industrial innovation and competitiveness needs new indentation-based measurement methods

Test/use length-scale

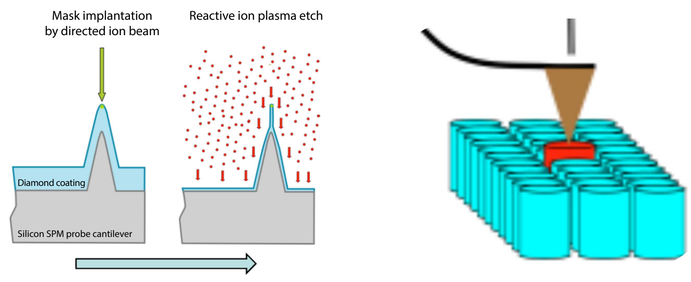
Microstructure size

Component dimension

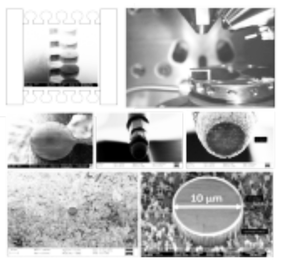
Combined length-scale

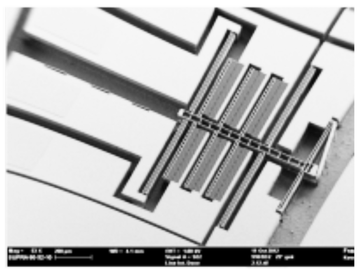
Strength A.B.L.E.

WP2 AFM & MEMS-scale instrument and test method improvement



1. Develop diamond-based probes 2. Develop MEMS-based IIT system
3. Data generation (nm to µm)





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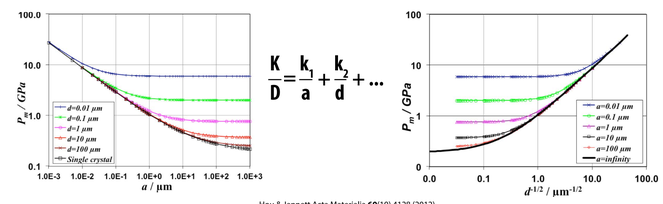
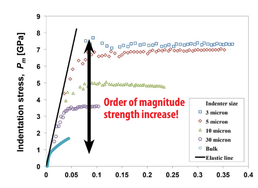
WP3 Data generation: size effects vs. length-scale and temperature

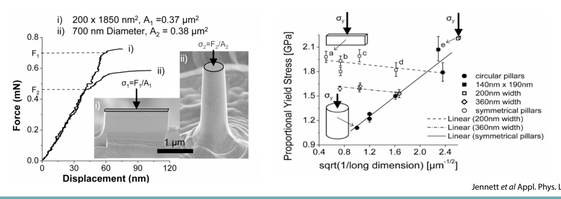


Hou & Jennett Acta Materialia **60**(10) 4128 (2012)

1. Materials procurement and sample preparation
2. Materials characterization



3. Data generation (µm to mm)
4. Thermal stability of size-enabled material strength



Jennett *et al* Appl. Phys. Lett. 95 123102 (2009)

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WP1 Models, algorithms, software and design rules

Validated models, algorithms and software

WP4 Data analysis to separate test vs. material size effects and develop new measurements methods that exploit test size-effects

1. Separation of residual stress effect from size effects 2. Separation of intrinsic and extrinsic size effects
3. Indentation property mapping (length-scale enabled)
4. Feasibility to use size effects in new beyond-state-of-the-art measurement methods for intrinsic properties/sizes

Strength achieved by length-scale engineering (Strength A.B.L.E.)

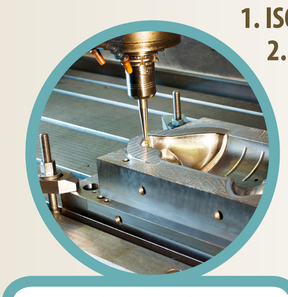
WP5 Creating Impact

1. ISO standards for mechanical property mapping
2. Knowledge transfer, Training, Exploitation
3. Industrial case studies & new products

Industrial Case studies

Case study 1: Novel 3D additive manufacture of prototype high pressure fluid manifold

Case study 2: Novel structure for photovoltaics and electronics packaging



Case study 3: Manufacture of better cutting tools

Case study 4: Soldered optics for energy saving, fuel ignition

Case study 5: Better material design of a selected steel system

Case study 6: Structural-health monitoring in the energy generation sector

WP6 Management & Coordination

Partners

NPL National Physical Laboratory · BAM · CMI Czech Metrology Institute · DFM Danish National Metrology Institute · INRiM Istituto Nazionale di Ricerca Metrologica · PTB Physikalisch-Technische Bundesanstalt Braunschweig und Berlin · Adama Innovations · CCFE · Queen Mary University of London · University of Leicester · Technische Universität Chemnitz · Anton Paar · elementsix · Fraunhofer IOF · Micro Materials Excellence in Nanomechanics · EMPA Materials Science & Technology

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