

Profilometry-based Indentation Plastometry (PIP)

Mechanical properties determined by indentation

Eurofins Qualitech AG offers services for quality control and trouble shooting in all areas of additive manufacturing such as development, prototyping and serial production. Our analysis spectrum reaches from industrial computed tomography up to material analytics.

PIP Fundamentals

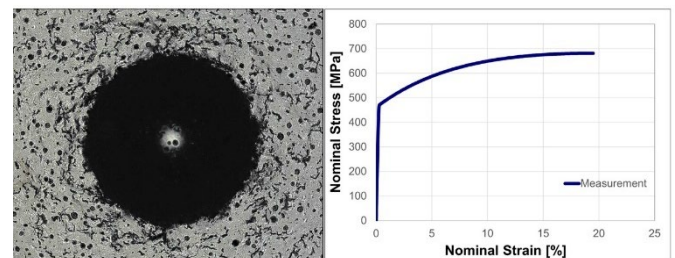
The Indentation Plastometer is a macro-mechanical benchtop testing device that extracts bulk tensile stress-strain curves from an indentation test. An inverse FEM modeling is used to deduce the stress-strain relationship from the resulting indent profile.

- If tensile specimens are not representative and sufficiently accurate for specific component areas and the test should rather be carried out locally on the component (e.g. in additive manufacturing or generally in case of complex geometries).

Comparison with conventional indentation methods

Other indentation methods, so-called “nano-indenters”, have been used to extract stress-strain relationships. However, “size effects” arise, which detrimentally impact the results. In fact, small regions generally do not exhibit the same deformation characteristics as the bulk.

A 0.5 – 1 mm silicon carbide spherical indenter is robust and wide enough to macroscopically characterize the investigated metal. Compared to other sharp indenters, a sphere is much less prone to becoming damaged than shapes having edges or points.



Exemplary PIP-Indentation and a PIP stress-strain curve



Plastometrex Equipment in the Eurofins Qualitech Facilities

Risk minimization and cost savings

In some cases, carrying out the measurements can offer an economic advantage over conventional tensile testing by reducing the overall testing effort. This is particularly true if metallographic microsections are already available and the customer requests additional mechanical data on several points on the sample.

However, the greatest savings effect lies in the risk minimization that can be achieved through a more precise dimensioning. Components can be designed more reliably using FEM simulations based on real characteristic values. Last but not least, the risk assessment of the remaining service life of an ex-service component can also be carried out with fewer risks using a PIP-analysis (e.g. only one component is destroyed and examined to take a decision for a whole set).

Our technology provides you with fast, precise and comprehensive insights into the mechanical properties of your materials.

Measurement method

The samples to be tested do not have to be available as metallographic sections. Small samples with flat and smooth surfaces can also be tested. In addition, the Brinell hardness can also be determined when measuring the yield strength and tensile strength.

Applications

When can this method be used successfully?

- In case the material is available in small quantities and is not sufficient to produce a tensile specimen (e.g. small components like sensors or in case of failures).
- If you want to determine the properties of unknown phases on a macro level (e.g. for a weld).



Exemplary Additively Printed Aviation Component [courtesy of Plastometrex]

