„MEASURING THE VISIBLE"

A NEW OPPORTUNITY TO MEASURE AND CLASSIFY SURFACE PHENOMENA AUTOMATICALLY

PCCL

Polymer Competence Center Leoben

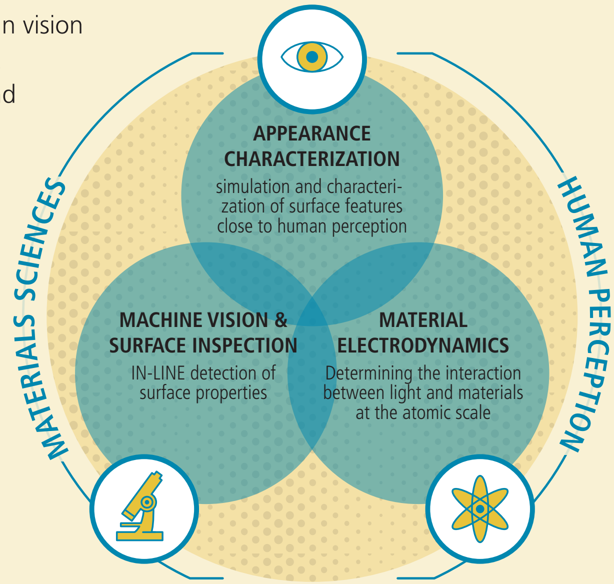
OUR APPROACH IS UNIQUE…

… because materials sciences „know-how“ and understanding of human vision both feed into the design of our inspection methods. This puts us into a position to precisely quantify a range of visual properties of materials and their surfaces.

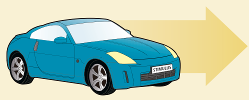
IN-LINE measurements correlate with the results of expert human assessment. This is made possible by **mathematical models simulating humans' perception** of surfaces.

For the first time, properties such as gloss, clarity and the brilliance of reflections are given a concrete value in results (in addition to sink marks, weld lines, streaks, printing errors and other production defects).

This allows PCCL to offer unmatched solutions with **numerous applications in the industry**, including the optimization of injection molding or extrusion processes.



STIMULUS



IMPRESSION

color
brightness
surface structure
surface defects

MEASUREMENT

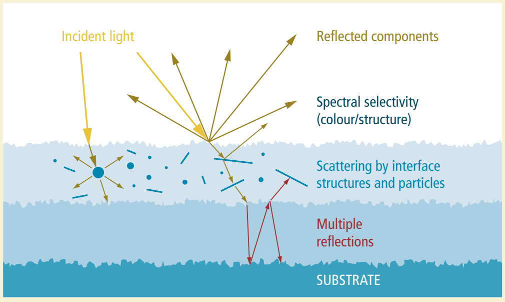
colorimetry
photometry
gloss
defect characterization

Stimulus and human perception
→ Model concept
→ Mathematical description
→ Measurement method
→ Setup & measurement

SIMULATION OF COMPLEX MATERIALS

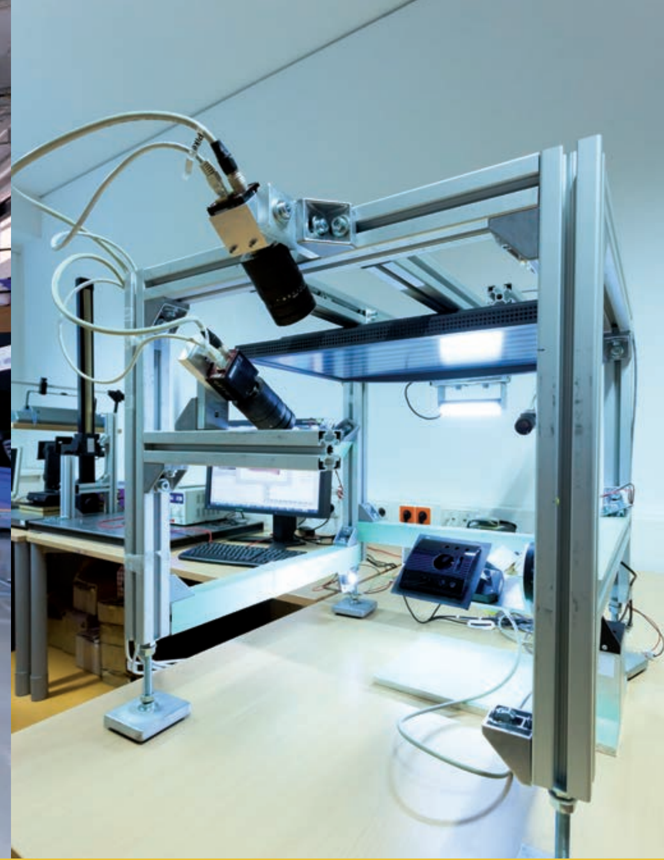
The calculation of reflected and absorbed light is based on Maxwell's Theory of Electrodynamics.

Optical material parameters, scattering surface structures and particles, layer thicknesses and the distribution of macroscopic inclusions affect the optical properties of materials.



THE ADVANTAGES AT A GLANCE

- Mathematical simulation and optimization of material properties (light reflection, absorption and scattering of structured, filled and coated materials)
- Material, component and end-product optimization
- Topographic analysis of surface structures and defects with the latest surface measurement techniques (eg IFM, MPCM, AFM, etc)
- Injection failure analysis on the basis of surface reflection and topographic data
- Unique, reproducible appearance and defect characterization
- Thresholds between visibility and invisibility of defects
- Classification and pre-selection of parts on the basis of precise quality criteria (for example prior to an expensive coating processes)
- Precision measurements of high gloss surfaces
- High processing speeds for IN-LINE quality control




GLOSS AND CLARITY MEASUREMENT AT AN UNMATCHED LEVEL

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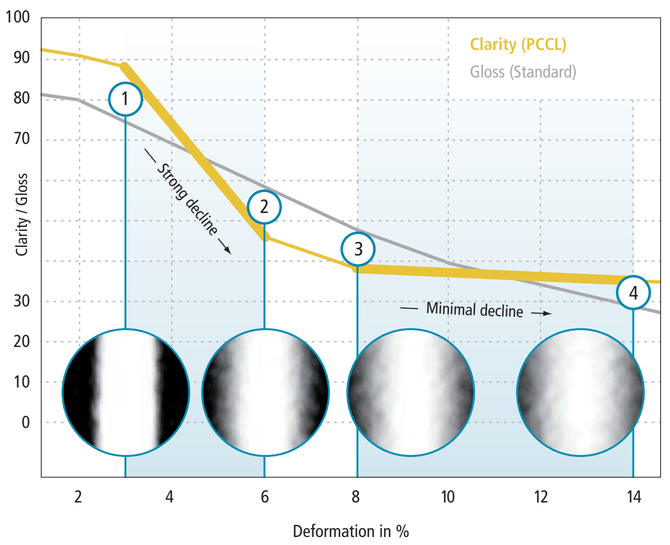
PCCL CLARITY MEASUREMENT

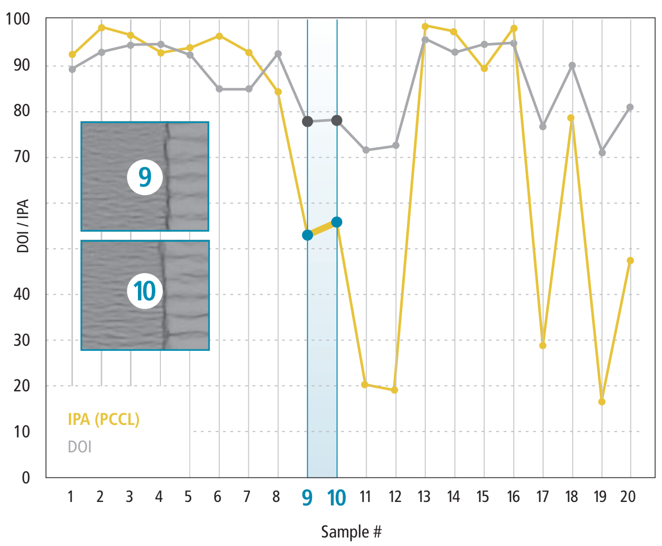
VS. STANDARD GLOSS MEASUREMENT



In the circles you see four pictures of different surface reflections. The difference perceived by the human eye between the gloss clarity of sample 3 and 4 is far less than that between the samples 1 and 2 – which the PCCL measurement system confirmed unlike the conventional measuring method.

PCCL INTENSITY PROFILE ANALYSIS (IPA)

VS. DISTINCTNESS OF IMAGE (DOI) MEASUREMENT



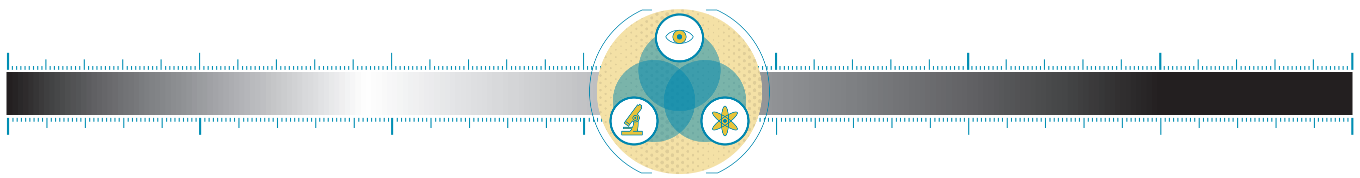
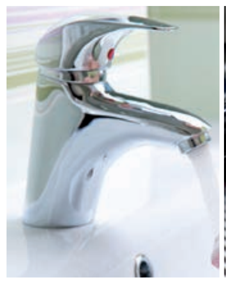
The intensity profile analysis of PCCL enables extremely accurate measurement of high gloss scatter typically created by extremely small surface structures. The measurement compares 20 paint coated and polished steel plates with various abrasives. Samples 9 and 10 are visually distinct, but conventional measurement methods do not produce clearly distinct results. IPA delivers significantly improved measurement resolution compared to classic DOI. The relevance of the high measurement accuracy is confirmed by a study in which 96% of respondents recognized the visual difference between samples 9 and 10.

The requirements placed on high-quality surfaces by industry are rapidly rising and demand new solutions in the measurement technology used in quality assurance.

Clarity is one of the PCCL-designed gloss measurement parameters, which sets itself apart by being based on the measurement of a very wide range of different gloss levels (from very dull to high gloss) and a leading perception analogue.

The **IPA** value supplements clarity. It represents a step forward from the conventional DOI (distinctness of image) gloss parameters through the measurement of image sharpness and fine structure contrast (connected to "image brilliance") for high-gloss surfaces. The IPA value can capture very small, yet often still perceptible, scattering from surfaces.

This measurement concept, compatible with conventional gloss and DOI measurements, is PCCL's answer to rising industry quality standards, focussing on the human visual perception of surfaces. The figures on the left show measurement examples.

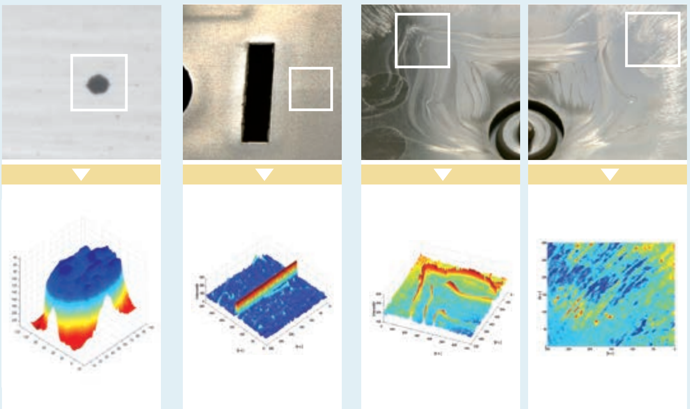





MEASURING THE VISUAL EFFECT OF INJECTION DEFECTS

The "artificial eye" enables the testing of flat and curved surfaces with an unprecedented correlation with human perception. The inspection system is a breakthrough innovation having solved significant problems in traditional inspection systems: the first is the possibility to automatically test perceptible differences in the gloss of plastic components; the second is the ability to capture components with surface curvature; and the third is the detection of the visual effect of high-gloss surfaces.

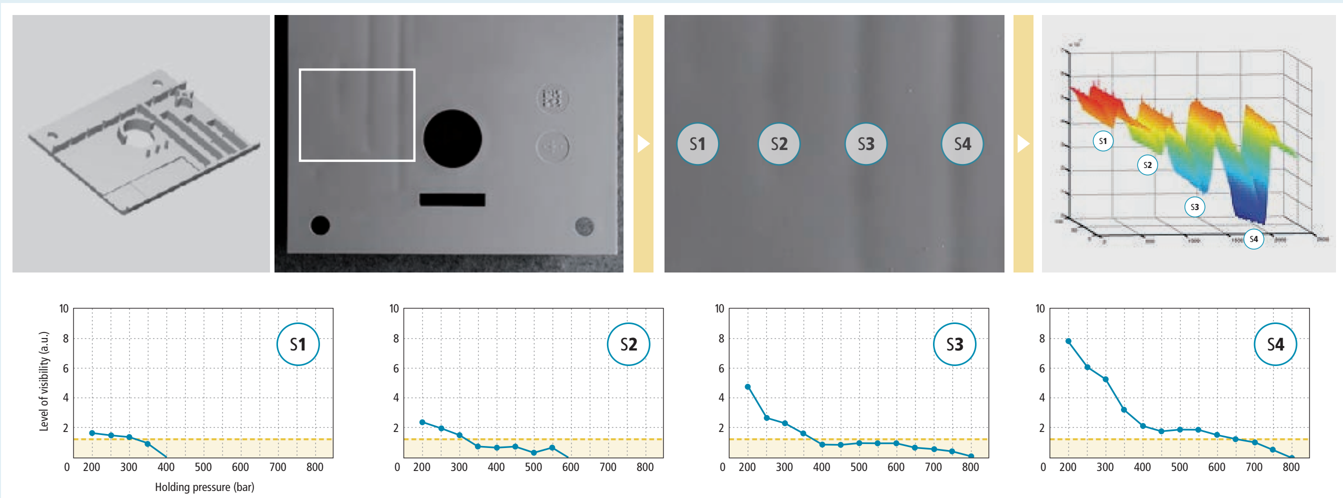
Pin holes | Weld lines | Moisture streaks, tiger stripes



SERVICES AND BENEFITS:

- Optimization of injection molded parts and manufacturing processes by clear, reproducible appearance and defect characterization, including setting the threshold between visible and invisible defects
- IN-LINE monitoring during the injection molding process
- Precision measurement of high gloss surfaces
- Extensive capture and analysis of surfaces (compared to the linear scanning of many alternative inspection methods)
- Classifications and pre-selection of parts based on precise quality criteria (eg prior to expensive coating processes)
- Full consideration to the reference chain tool – molded component – perception

Sink marks

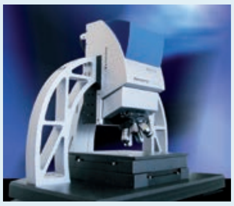


When filled with hot polymer melt, a non-optimal accumulation of cooled material is formed at the junction between a rib and the molding plate, which after cooling can result in "sink marks". A wider rib results from a greater accumulation of material in a more pronounced sink. The phenomenon is counteracted by pressure to compensate for shrinkage.

Inspection of curved composite parts: example applications

- Decorative parts in automotive interiors with special surface structure or high gloss surfaces
- Evaluation of a number of aspects of shine or the rheologically related structure, eg of automotive paints
- High-gloss components such as headlight reflectors
- Components of high-tech consumer products such as mobile phones, laptops, LCD screens, etc
- Continuously extruded products, such as window profiles
- Decorative parts in architecture
- Surface modified tools for injection molding
- Coatings such as paints and metal coatings

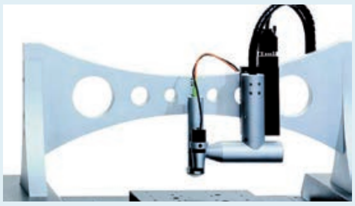
MICROSCOPIC & TOPOGRAPHIC CHARACTERIZATION METHODS



Alicona InfiniteFocus

Nanosurf FlexAFM

Zeiss microscope
(+ digital evaluation)



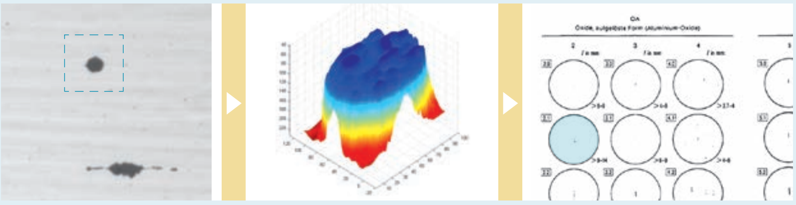
FRT MicroProf

Our measurement technique for the detection of topographic structures is the state of the art. It allows us to test the microscopic structural features of components and surfaces with a **resolution on the nanometer scale**. Also large measurement areas and volumes can be reproducibly measured. The potential for automation makes the measuring systems suitable for numerous applications, of which the following is a selection:

- Roughness (Ra, Rz, Sa, Sz, etc) with small radii and steep edges
- Measurement of form and dimensional accuracy
- Measurement of materials with different surface-reflection characteristics
- Detecting topographic structure for defects such as weld lines and sink marks
- Defect analysis with a view to the manufacturing process, for example weld lines
- Layer thickness determination

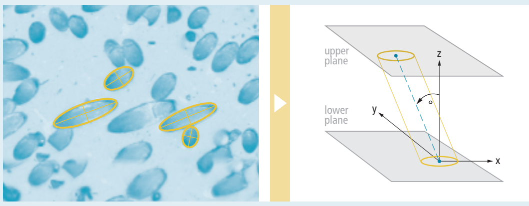
FURTHER SERVICES

Automated classification of material properties



IN-LINE detection of macro- and microscopic material inclusions followed by an automated classification in line with international norms.

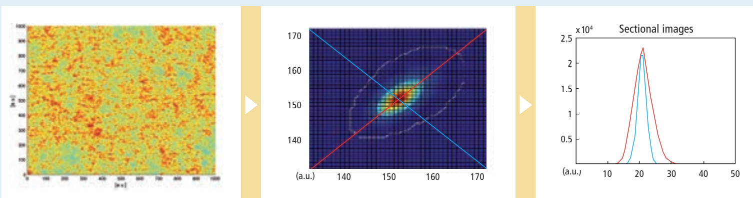
Characterization and optimization of fillers



Our new methods of characterization of fillers and inclusions, for example gas bubbles, help to significantly improve yield information and so more accurate analysis, for example of filler density and orientation. Determining the orientation of fillers and fiber composites can, for example, be carried out automatically.

Pictured left: micrograph of a glass fiber reinforced polyamide (Image: C. Guster & G Pinter)

Measurement of transmission characteristics of materials



Our radiographic measurement methods can be modified for a range of semi-transparent materials. This technology is also applied in the automated measurement of optical homogeneity and the detection of local inclusions.

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Contact: Dipl.-Ing. Dr. Dieter P. Gruber
Polymer Competence Center Leoben GmbH
Roseggerstraße 12, A-8700 Leoben
Tel.: +43 3842 42962-11, Fax: +43 3842 42962-6
dieter.gruber@pccl.at, www.pccl.at

COMET

PCCL is a *K1 Center* funded through the COMET competence center program of the Federal Ministry for Transport, Innovation and Technology, the Federal Ministry of Economics and Labor and the provinces of Styria, Lower Austria and Upper Austria.