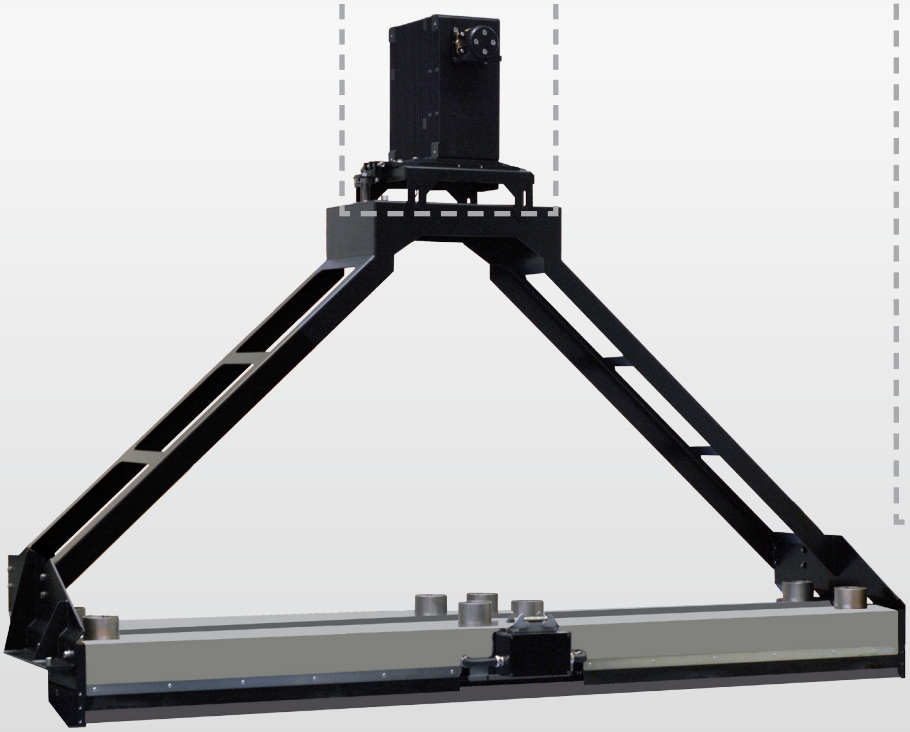
Analytical
Imaging
Process
technology

HYPERSPECTRAL NIR CAMERAS



KUSTA1.7MSI
KUSTA1.9MSI
KUSTA2.2MSI^{sens}

PP-MG-KUSTAx.xMSI-1807

LLA Instruments GmbH & Co. KG

KUSTA1.7MSI – KUSTA1.9MSI – KUSTA2.2MSI^{sens}

Purpose

The imaging cameras KUSTA1.7MSI, KUSTA1.9MSI and KUSTA2.2MSI^{sens} (KUSTAx.xMSI) are ideally suited for recycling applications. A distortion free optical lens ensures a high spectral and spatial resolution (up to 320 adjacent measurement tracks) for the measurement of a material stream. Due to high frame rates of the camera, the analysis and identification of small particles is possible at high conveyor belt speeds of up to 3 m/s. The high spatial resolution enables the detection of inhomogeneities in complex material mixtures. The camera systems are widely used for plastics-, waste paper- and construction & debris (C&D) recycling.

Setup

The reflection of the detected objects is captured by the optical lens of the camera and projected onto the InGaAs sensor array. A complete NIR spectrum is recorded for each image point (max. 320 / max. 192) along the line-shaped detection area. A spatially resolved analysis of the material composition across the object surface is possible by a line scan of the object. The high spatial resolution permits the identification of small parts in a material stream. The camera is offered in combination with an illumination unit PMAmsi, installation bridge, RGB line scan camera and an industrial PC with control- and analysis software (figure 1).

Key characteristics

- High resolution 2D-spectrograph with distortion free NIR image
- Camera with cooled InGaAs sensor array
- Frame rate of up to 795 Hz - achieved by purpose designed electronics
- Comprehensive tools for setup and service
- Industrial PC including Windows® 7 embedded (or higher) OS
- Analysis routines for standard sorting applications in recycling included

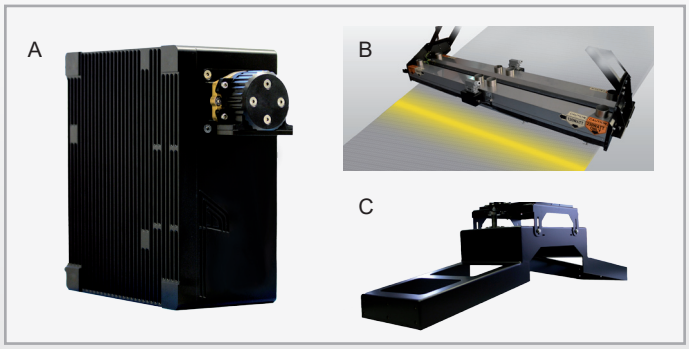


figure 1: Setup: A - camera, B - illumination unit, C - installation bridge

Applications for Recycling

LLA devices are utilised for wide application fields. The sorting task can be changed by simply selecting a different identification routine in the device software. Several ready-to-use applications are available for recycling.

- **Household waste (idHwaste)**
  Identification of: PET, PE, PP, PS, PVC, PA, PE-bottles, PE-foil, paper, cardboard, wood, liquid packing board (TETRA), textiles, PET-bottles with PE-, PP- or PVC-label, HD-PE, LD-PE , PET and PET-G (figure 2)
- **Waste paper (idPaper)**
  Identification of: Office paper, magazines, newspapers, catalogues, cardboard, folded box, liquid packaging board (TETRA), PET, PE, PP, PS and PVC (figure 2)
- **Electronic waste / WEEE (idEwaste)**
  Identification of: ABS, PS, PA, PBT, PC, PE, PP, PET, PVC, PMMA, PUR, POM, PC+ABS, PPE+SB, PVC+ABS, ABS+TBBPA, ABS+TBBPAep, PS+TBBPA, PS+TBBPEep, paper, cardboard and wood (figure 2), (figure 3)
- **PET-Flakes (idPET-Flakes)**
  Identification of: PET, PE, PP, PS, PA, PC, PVC, PMMA, PET+PVC and silicone (figure 2)

Applications for Recycling

- **Printed circuit boards (idPCB)**
Identification of: ABS, PS, PA, PBT, PC, PE, PP, PET, PVC, PMMA, PUR, POM, PPE+SB, printed circuit boards, epoxy resin drenched printed circuit boards, silicone foils, melamine formaldehyde resins (MF), liquid crystal display (LCD), papers, cardboards and wood (figure 2)

- **Fractioned RC-construction material in C&D (idCM)**
Identification of: Gypsum, concrete/lightweight concrete, sand-lime brick, gas concrete, brick and extraneous materials (wood, paper/cardboards, plastics) (figure 3)

- **Extraneous material in C&D (idDebris)**
Identification of: Plastics, wood, paper, cardboards, gypsum and gas concrete in mixed debris (figure 3)

figure 2: Applications for recycling by NIR technology

figure 3: Applications for recycling by NIR technology

Analytical and Control Software

The KUSTAx.xMSI cameras are delivered including a comprehensive set of software. The control software KustaMSI (figure 4) permits adjusting of camera parameters and monitoring of camera status. In addition to the camera control options, several standardised interfaces are implemented in KustaMSI for data transfer to an external process control device. Important device parameters are password protected and therefore changeable by service personnel only. In addition, the application routine can be changed, enabling an easy adaption of the hyperspectral NIR-cameras to different sorting tasks. LLA offers chemometric software for application development and software for visualisation of material streams in real time (figure 5).

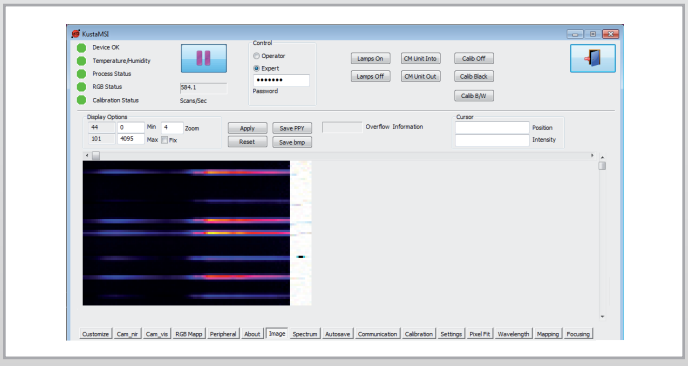


figure 4: Device control software KustaMSI, camera picture

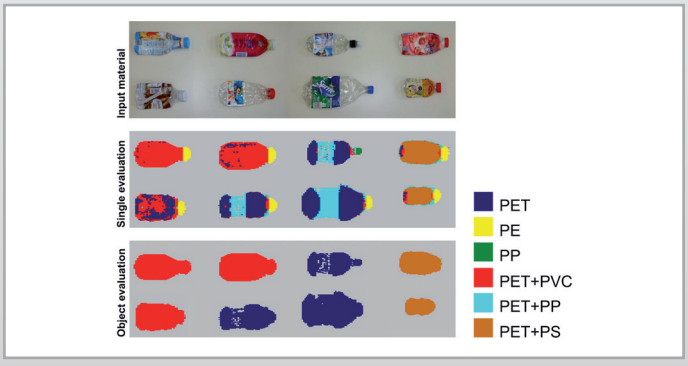


figure 5: Visualisation software for labeled PET-bottles

Technical data

NIR Camera	KUSTA1.7MSI	KUSTA1.9MSI	KUSTA2.2MSI^{sens}
Wavelength range	0.95 µm – 1.7 µm	1.32 µm – 1.9 µm	1.62 µm – 2.19 µm
Spectral resolution	< 8 nm		
Exposure time	100 µs – 5 s	1 µs – 10 ms	
Scan rate	Max. 270 Frames/s Full Frame, 5000 F/s with smallest ROI Mode	Max. 795 Hz, ROI Mode not available	
Adjustable integration time	Min. 10 µs, Max. 3000 µs	Min. 1 µs, Max. 10 ms	
Typ. integration times for illumination PMAmsi	~2100 µs	~350 µs	~500 µs
Number of measurement tracks	Max. 320	Max. 192	
Lens	Standard: Zeiss F2.4 / 10 mm, NIR-corrected; further lenses available upon request		
Power supply camera	24 V, 2,5 A		
Environmental operating temperature	0 °C up to +50 °C		0 °C up to +45 °C
Humidity	20 % up to 90 % (non-condensing)		20 % up to 80 % (non-condensing)
Weight camera	16.8 kg		
Dimensions camera	295 mm x 166 mm x 345 mm (LxWxH)		

Setup	KUSTA1.7MSI	KUSTA1.9MSI	KUSTA2.2MSI^{sens}
Working distance = Distance camera - conveyor belt	~Band width x 1,04		
Conveyor belt speed	Up to 2.5 m/s		
Sorting material width	Starting from 2 mm (depending on the band with)		
Process interface	TCP/IP or UDP protocol		
Connections	Push-Pull plugs, 1 Gb Ethernet		
Protection level	IP67		
Scope of delivery	Camera, control-PC with control and analysis software, power supplies for camera and control PC		
Optionals	Deflection unit NIR lens, installation bridge (above conveyor belt setup or free fall setup), RGB line scan camera, control cabinet, automatic calibration, mirror unit		

Illumination Unit	PMAmsi
Characteristics	Doublesided with reflectors for 500 mm (LR50) vertical clearance
NIR light source	Halogen light bulbs 120 W / 230 V AC or 115 V AC
Conveyor belt width	500 mm up to 2000 mm with one camera 2000 mm up to 2800 mm with mirror unit or two cameras
Protection level	IP65
Illumination area in 500 mm distance	40 mm x measurement width

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