



The ID for the Plastics Industry

PRODUCT AUTHENTICATION AND IDENTIFICATION
FOR EVERY STEP IN THE LIFE CYCLE



PRODUZIERT
IN DER EU

TAGTEC

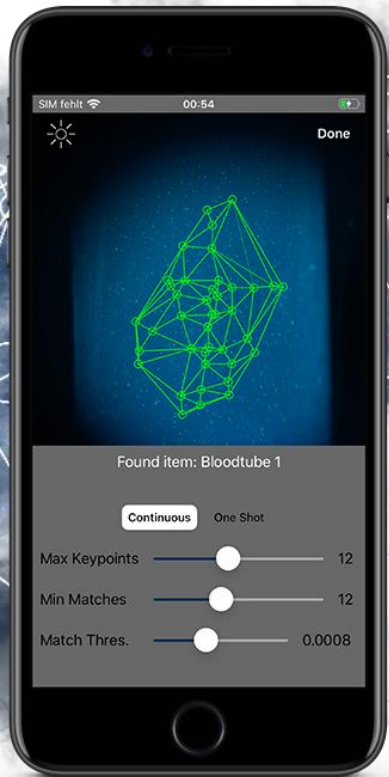


TAGTEC is a groundbreaking, market-ready technology, that gives plastics a distinctive signature identity – similar to a fingerprint.

Markers (taggant particles) added to the masterbatch create an intelligent plastic that can be used in a variety of applications. It carries the added information like DNA. Which information, you define.

The TAGTEC advantages

- Product safety
- Material detection (Material-ID)
- Single part detection (Product-ID)



TAGTEC

THE TAGTEC FORMULA



+ TAGTEC-Markers
+ TAGTEC-Sensors
+ TAGTEC-Masterbatch

= INNOVATION

Three innovative, leading companies have joined forces to take the production of intelligent plastics to a new level.

The markers, which can be activated by sensor technology and are added during the production of plastics, enable the secure transmission of product- or material-specific information. Just as if the product could tell where and how it was made, what it contains or whether it is an original or an imitation.



COMPETENCE IN **MARKERS**



COMPETENCE IN **SENSORS**



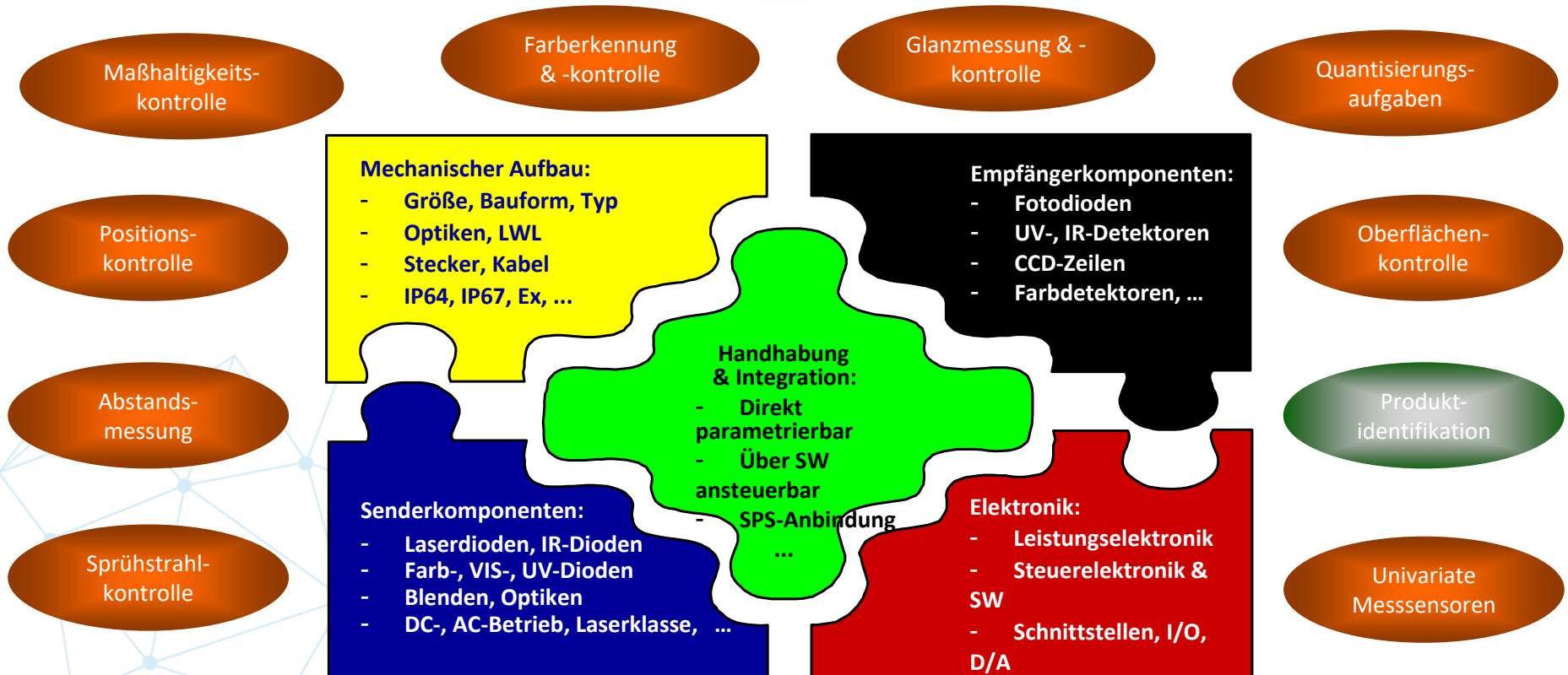
COMPETENCE IN **MASTERBATCHES**

Sensor Instruments – WHO WE ARE



- ❖ Since its foundation in 1992, [Sensor Instruments Entwicklungs- und Vertriebs GmbH](#) has proven a very innovative, expanding company in the field of sensor technology. Our main focus lies in the areas of development, production, and marketing of high-quality sensor systems and special measurement technology equipment for application in all fields of industry.
- ❖ In addition to the standard sensors Sensor Instruments primarily develops and manufactures customer-specific, “Individual sensor systems”. These high value systems, together with Product marking and product tracking solutions, and Engineering services will be marketed via our sister company Sensor Instruments Systemtechnik GmbH.
- ❖ Sensor Instruments Systemtechnik resources will also provide support for our international sales partners
- ❖ Strategic alliances [Gabriel Chemie GmbH](#), the expert for [TAGTEC masterbatch](#) solutions in the plastics industry. Additionally we utilize our expert network for the process integration of security taggants ([LUMI-TAG](#)), and work closely with [Leuchtstoffwerk Breitung](#) to provide new markers to our customers.

Sensor Instruments – OUR CORE COMPETENCIES



“Let's make sensors more individual” → Unsere Kompetenz für Ihren Sensor!

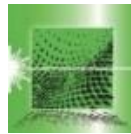
Sensor Instruments – WHAT WE DO



Our range of optical sensor solutions and services includes :



Individual sensor systems*



Surface inspection and gloss measurement



Dynamic distance measurement and dynamic positioning



Color control and color measurement



Service and Engineering



Product marking and product tracking*



Counting and triggering



Distance measurement and positioning



Fiber optics and accessories

TAGTEC-SENSORS – A HISTORY



LUMI-SPECTRO-256-LWL-IRLVIS

DE102006032701B3

2005

1G - LUMI-30-IR/IR

2006

2G - LUMI-MOBILE-50

2008

3G - LUMI-INLINE + LUMI-MOBILE

DE102011108180B4

2011

4G - LUMI-MOBILE-SL

DE102015005304B3

DE202016002731U1

2016

4G - LUMI-INLINE-SL

DE102017108983B4

2017

LUMI-STAR-MOBILE

2018

LUMI-STAR-INLINE

DE102019127894A10

2019

5G - LUMI-TAU-MOBILE-JR

DE102020113252A1

DE102020113299B3

LUMI-TAU-MOBILE-LC

DE102021111015A1

2021

**5G - LUMI-TAU-MOBILE-CL
5G - LUMI-TAU-MOBILE-AL**

WO2021228922A1

2022

WO2021228940A1

HOW DOES TAGTEC WORK?



**SELECTED MARKERS
(MARKER SYSTEMS)**



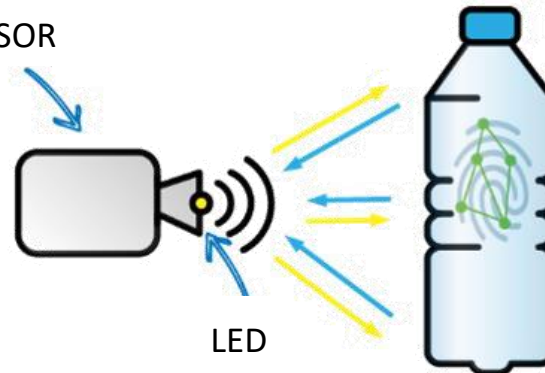
**INTEGRATED INTO THE
PRODUCT BY MASTERBATCH**



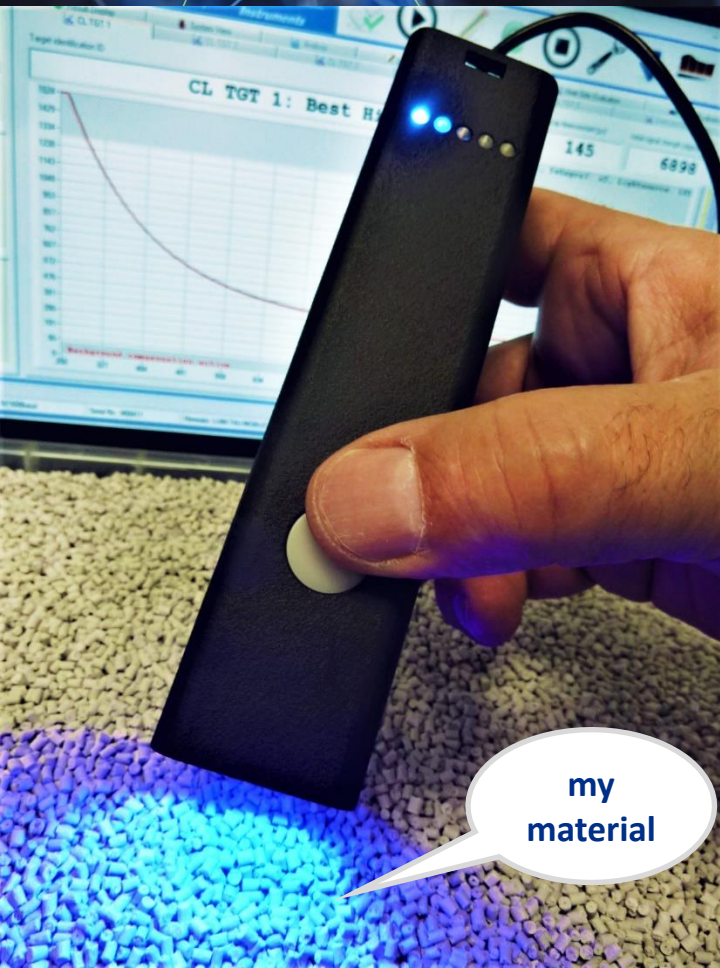
**CAN BE ACTIVATED AND
READ OUT WITH SELECTIVE
SENSORS**

TAGTEC uses the principles of encryption (coding) and decryption (decoding). The marker-bound, encrypted information can be decoded using patented technology via special sensor technology - reliable and forgery-proof.

SENSOR



THE DECRYPTION



In order to decode the embedded information, two methods are available:

STAR, in which the reading takes place on a defined area, for example in a bottle cap. A sensor connected to a cloud illuminates the previously defined area, reads out the product information stored there and transmits it to the cloud.

➔ **Product-ID – single part detection**

TAU is the name of the system in which information can be read at any point on the product. The response signal depends on the mixture of taggant particles.

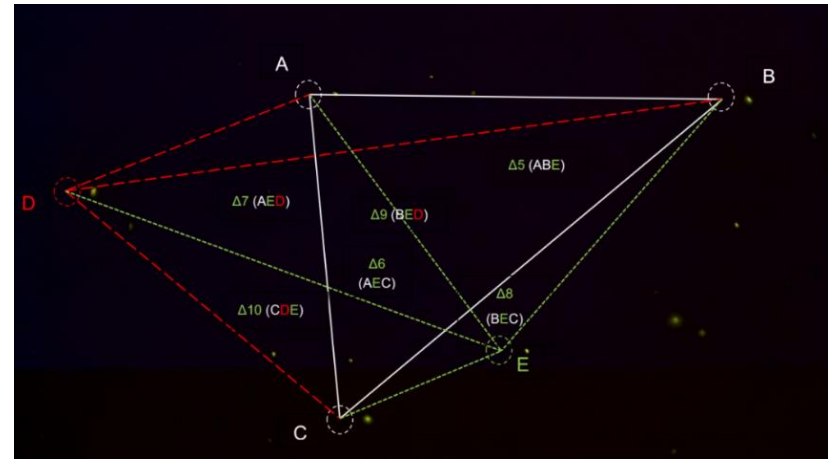
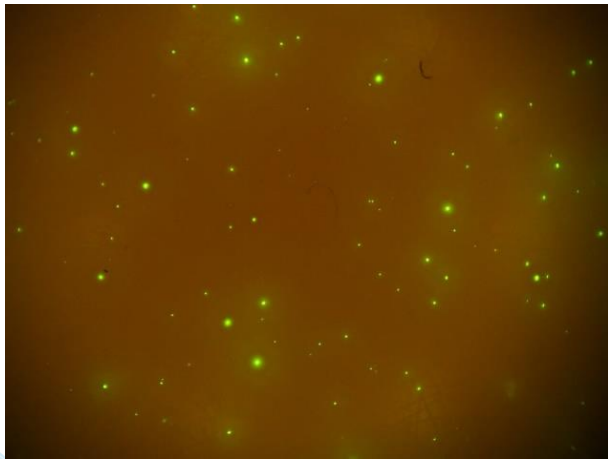
➔ **Material-ID – authentication, recycling, ...**

Solutions tailored and optimised to ...

- Necessary product safety
- Product-specific applications
- Combined functionalities

TAGTEC – STAR

FROM FLUORCESZENCE PATTERN TO PRODUCT-ID



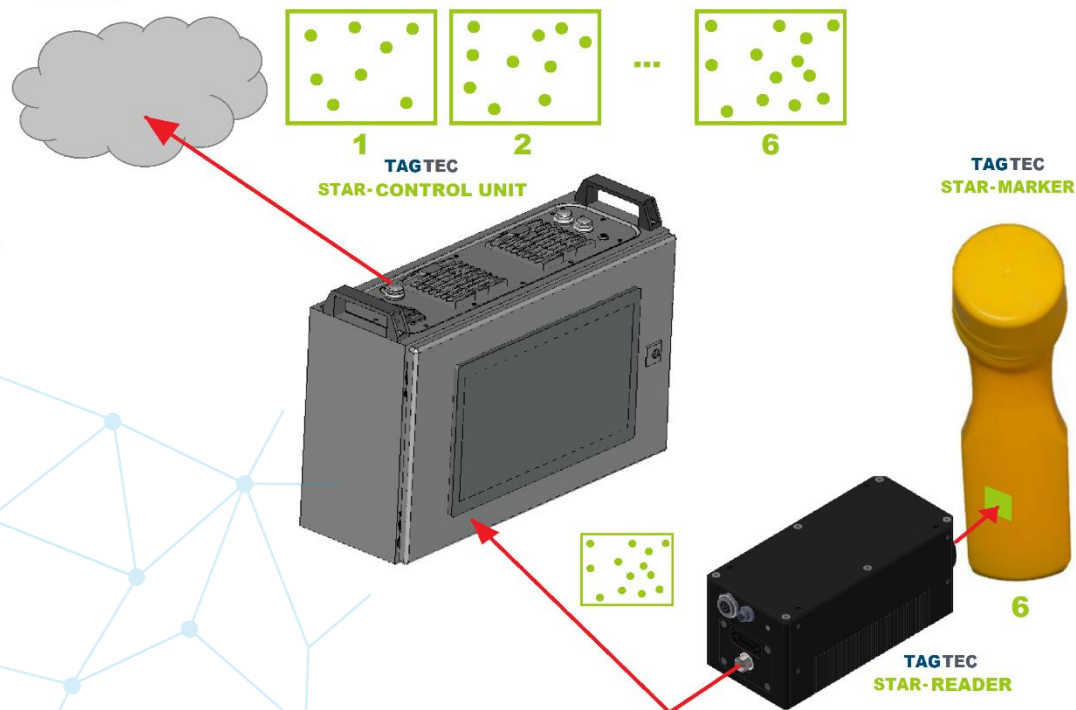
- Bildaufnahme vom Sternenhimmel (BLAU → GRÜN)
- Zufallsverteilung der Leuchtpunkte (forensisch)
- Reproduzierbare Interpretation der Bildpunkte an einer definierten Stelle des Substrats/Produkts
- Anwendungsoptionen:
 - Einfache Statistik zur Leuchtpunktdichte (Density)
 - Kodierung des Zufallsmusters (forensischer Code)

- Bildkodierung (Codes) bedeutet Informationsreduktion!
Z.B. Digitalbild mit 5 – 10 MB Daten → Code-Daten 1 – 2 KB
- Mathematische Algorithmen → Code für das Leuchtpunktmuster
- STAR-Code:
 - Rotations- und maßstabsinvariant
 - Einzelproduktverfolgung, höchste Sicherheitsstufe
- Codes in Datenbank speichern, Datenbankabfrage zur Prüfung

LUMI-STAR - THE CONCEPT



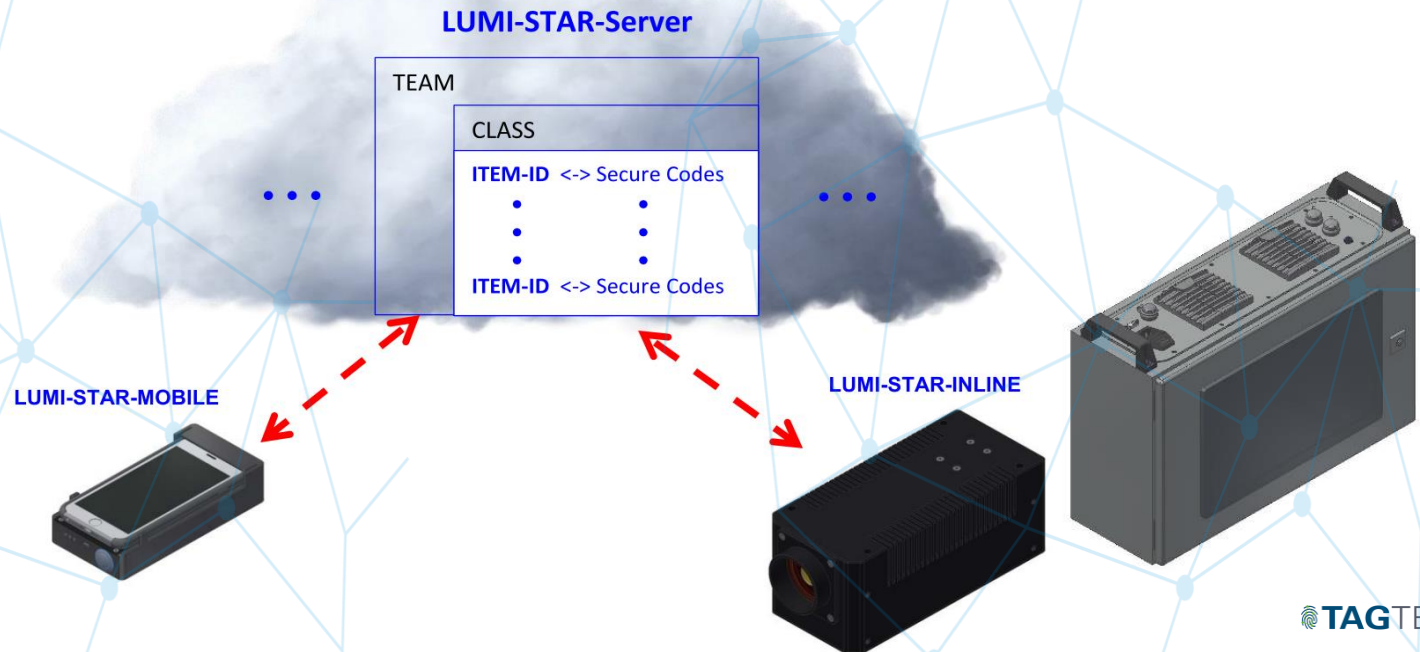
- Optical system of the LUMI-STAR makes luminous dot patterns visible to a camera
- Authentication is done by special software (different evaluation algorithms possible)
- LUMI-STAR-MOBILE – handhelds & LUMI-STAR-INLINE – fixed installed inline systems



LUMI-STAR - SYSTEM ARCHITECTURE



- LUMI-STAR-SERVER: Central database for storing the codes and the associated product data (**ITEM-ID**)
- LUMI-STAR-MOBILE: Mobile devices with smartphone + app for recording and authenticating codes
- LUMI-STAR-INLINE: Inline systems for automatic recording and checking of codes in production



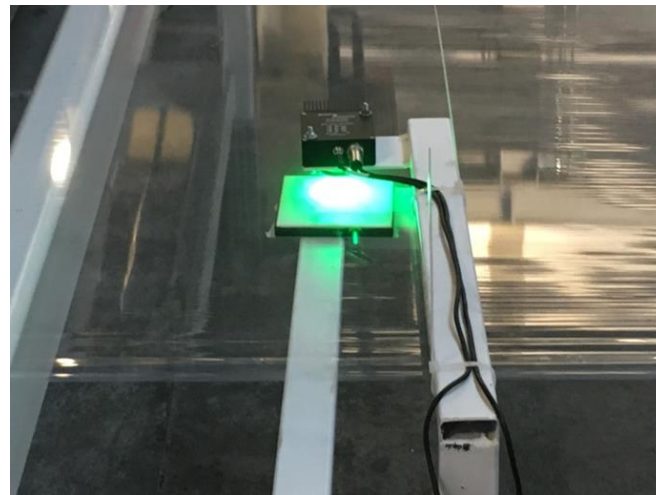
LUMI-STAR-MOBILE – HANDHELDS for STAR-CODES



- ❖ Handheld devices for decoding luminescent markers in products
 - Luminescence analysis in conjunction with smartphone camera, computing power and communication.
 - Various light sources and filter options.
 - Evaluation of the luminescence pattern: Simple statistics and STAR coding for Track & Trace



INLINE-SENSORS TO MEASURE FLUORESCENCE – INTENSITY & CLOR DETECTION



Inline-Kontrastmessung, rechts mit Offline-Aufsatz als Handgerät

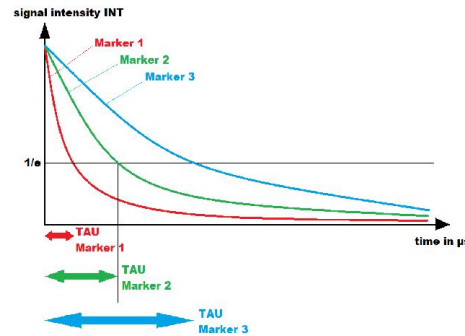
- Various excitation light sources
- Incident light sensors and fiber optic systems
- Intensity and color analysis

TAGTEC TAU

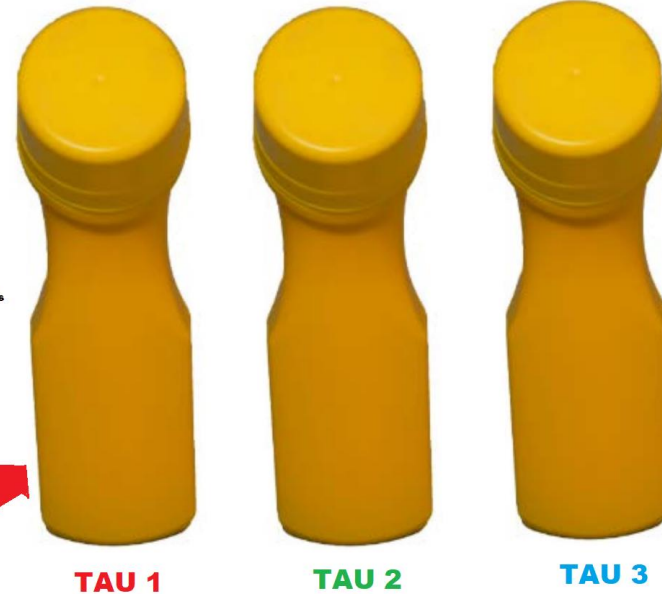
– MEASUREMENT OF MATERIAL-SPECIFIC PHOSPHORESCENCE



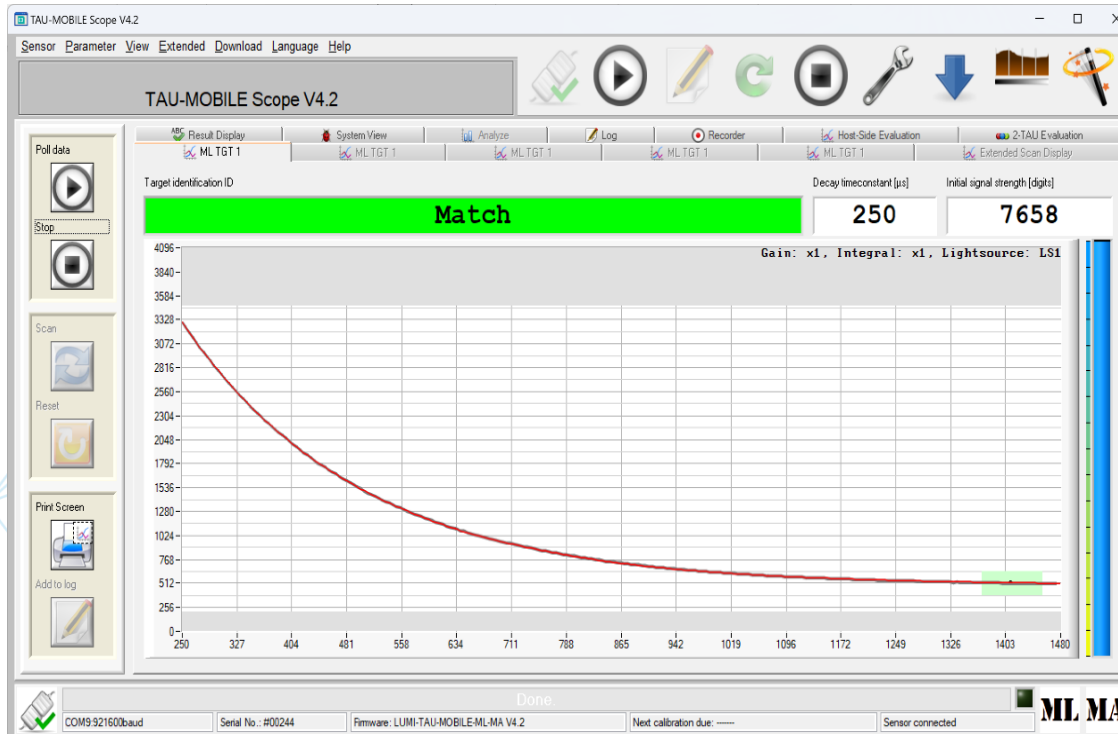
TAU → Measurement of the characteristic decay constant of the integrated taggant



TAGTEC
TAU-MARKER



LUMI-TAU DETECTORS – INSTRUMENTS FOR PHOSPHORESCENCE ANALYSIS



Decay timeconstant [μ s] = TAU = 250, Initial signal strength [digits] = 7658

LUMI-TAU-Measurement:

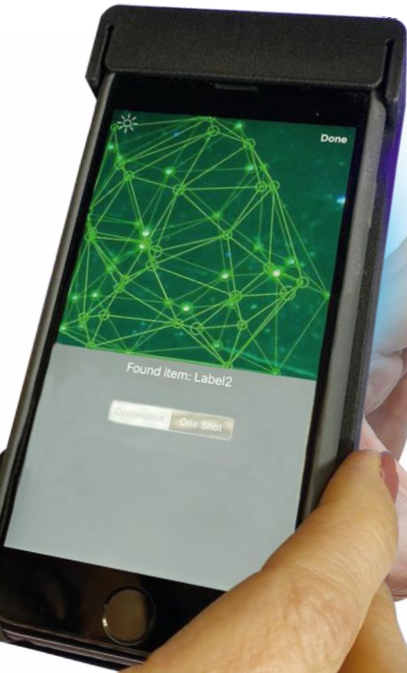
- Precise identification of the marker type and insertion quantity by two numerical values.
- Analysis of the decay constant TAU [μ s], as well as the start intensity (INT) of the signal.
- TAU marker:
 - Very low concentrations detectable!
 - NIR penetrates surface layers
 - Hidden feature, since neither excitation nor emission is visible.
 - Excitation with NIR LED enables detectors without laser protection class!
- LUMI-TAU detector types:
 - Handhelds: LUMI-TAU-MOBILE-...
 - INLINE sensors: LUMI-TAU-INLINE-
 - Lab instruments LUMI-TAU-LAB-...

SECURITY – PROTECTION AGAINST COUNTERFEITS



ORIGINAL

COUNTERFEIT



The worldwide economic damage caused by counterfeit products is immense. This problem was the starting point and incentive for the development of TAGTEC.

Protect your products with TAGTEC technology! The method is based on the combination of security markers and sensors. By selecting the marker-sensor pairings, you determine the level of security you require.

More product safety - for you and your customers.

PRODUCT-ID – TRACK & TRACE OF SINGLE PRODUCTS



INFORMATION – DETECTION & CODING OF SINGLE PRODUCTS



TAGTEC gives plastic parts an individual product DNA. This makes it possible to fully document production processes - from manufacture to distribution. It does so discreetly and invisibly, without visually disturbing codes, and can be used by all partners in the supply chain. Always individually tailored to your needs. This makes TAGTEC forward-looking and »blockchain ready«.

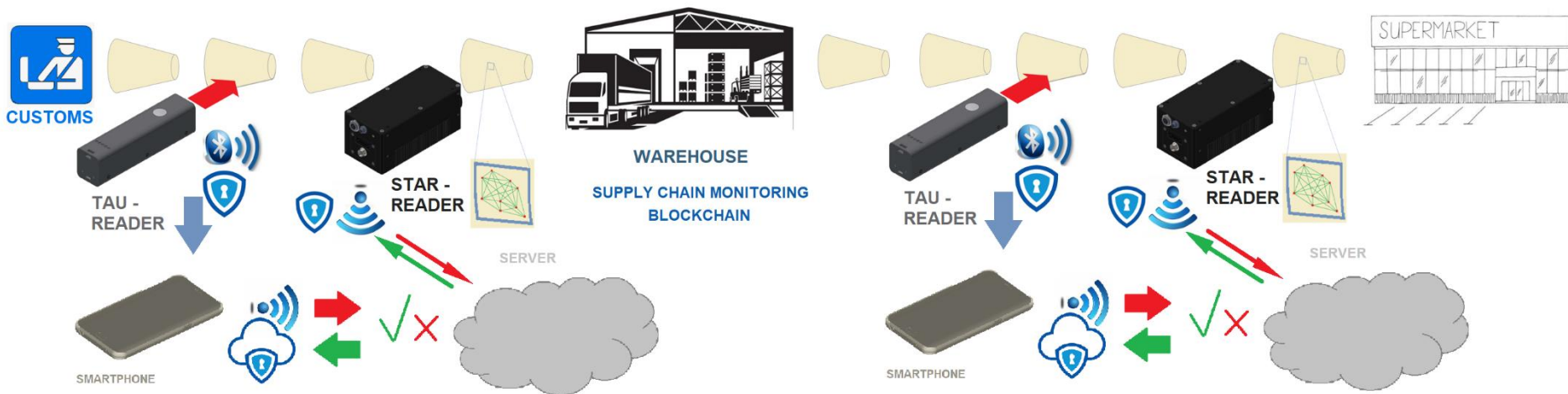
Advantages of TAGTEC STAR coding:

- Marker is anchored tamper-proof in matrix
- Marker arrangement cannot be copied
- Positioning on the surface can be freely selected
- No visual interference
- Individually programmable for all supply chain partners

IDENTIFICATION AND AUTHENTICATION IN THE BLOCKCHAIN – PRODUCT-ID OR MATERIAL-ID?



Bei jeder Blockchain ist die sichere Authentifizierung und Identifikation des Produktes Grundvoraussetzung. Mit TAGTEC kann dies durch eine individuelle Produkt-ID (STAR), oder auch eine Material-ID (TAU) in Kombination mit einem 2D-Digital-Code umgesetzt werden.



SUSTAINABILITY – TAGTEC MATERIAL-ID FOR AN OPTIMUM RECYCLING OF MATERIALS



With TAGTEC, it is possible to bring packaging from any recycling waste management scheme (Germany: »Gelber Sack«) into a closed technical production cycle – an active contribution to resource and climate protection. In addition, the technology enables the analysis of material components, for example the control of approved ingredients.

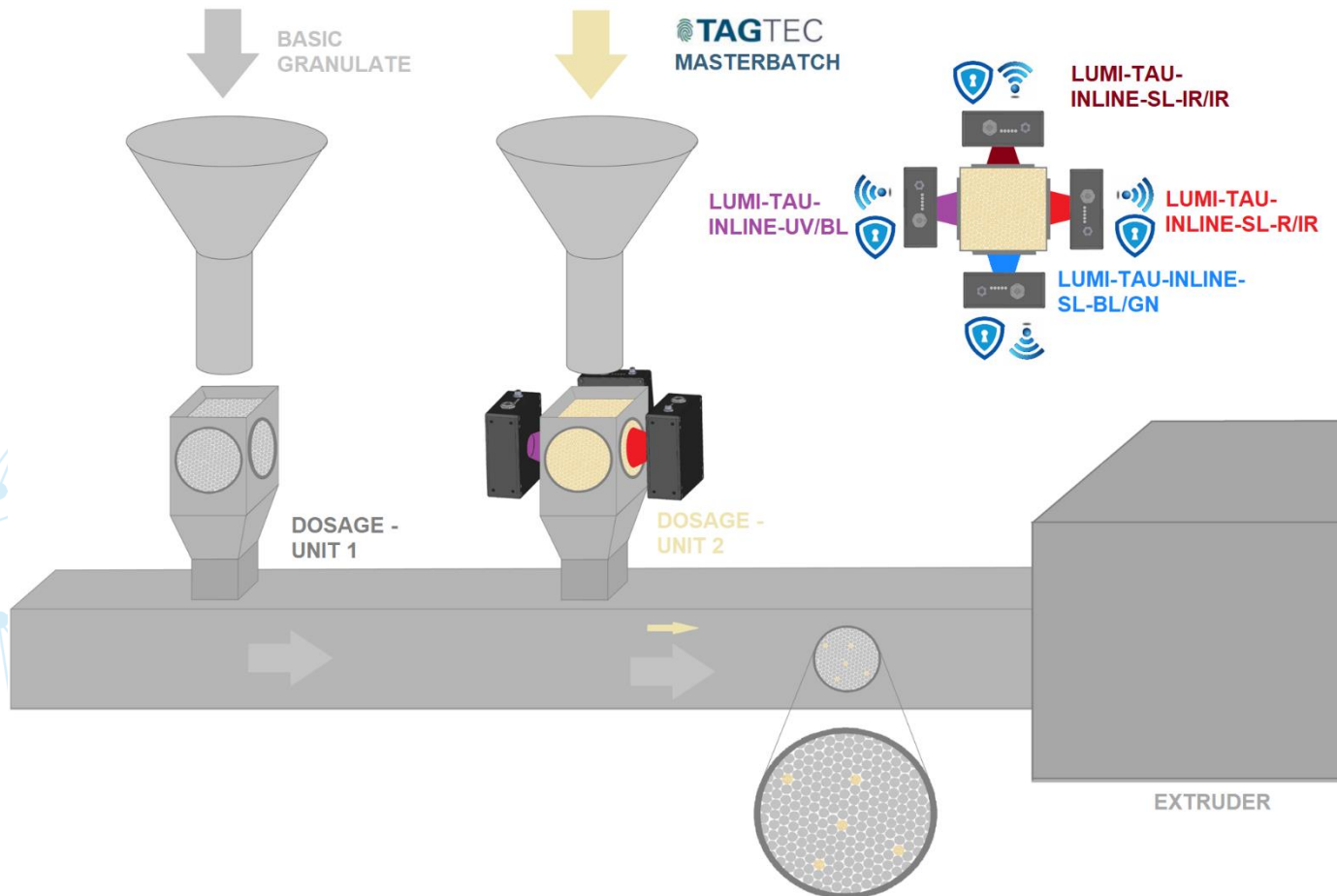
TAGTEC enables an effective circular economy, ensures more sustainable products - and thus less waste, less environmental pollution and more future.

TACTEC recycling applications:

- Additional sorting criteria by application, product group etc.
- Differentiation between FOOD material and NON FOOD material during recycling
- Further freely definable recycling sorting options
- Recovery of valuable ingredients with defined properties and additives



TACTEC IN THE RECYCLING LOOP – INCORPORATION INTO THE PLASTIC



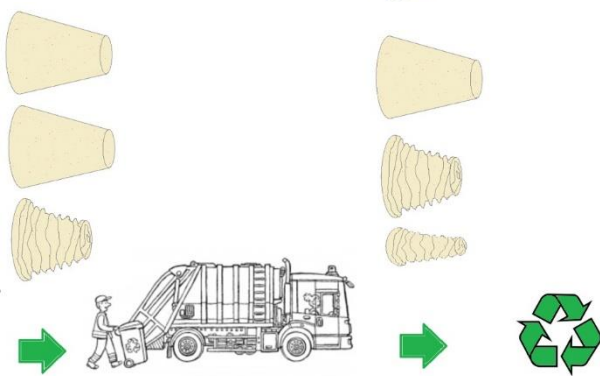
? Material-ID for plastic applications?

- Nahrungsmittel TAGTEC (FOOD)
- Waschmittel TAGTEC (DETERGENTS)
- Körperpflege TAGTEC (BODY CARE)
- Chemische Spezialprodukte TAGTEC (SPECIAL CHEMICAL PRODUCTS)

TACTEC IN THE RECYCLABLE LOOP – COLLECTING AND SORTING

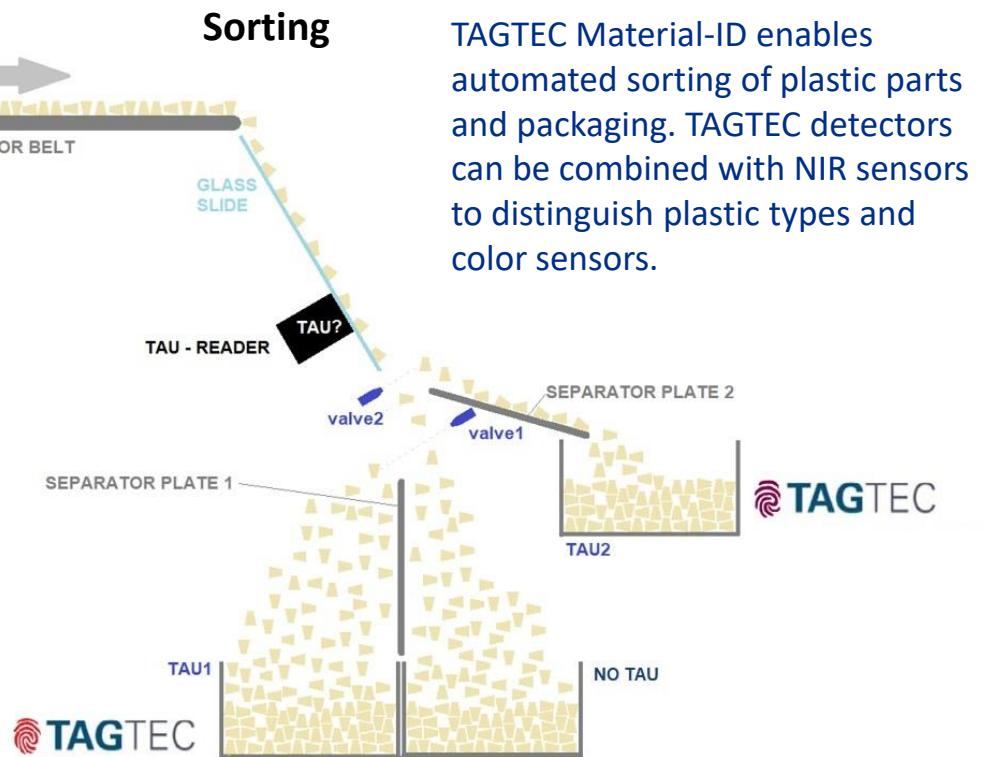


Collecting



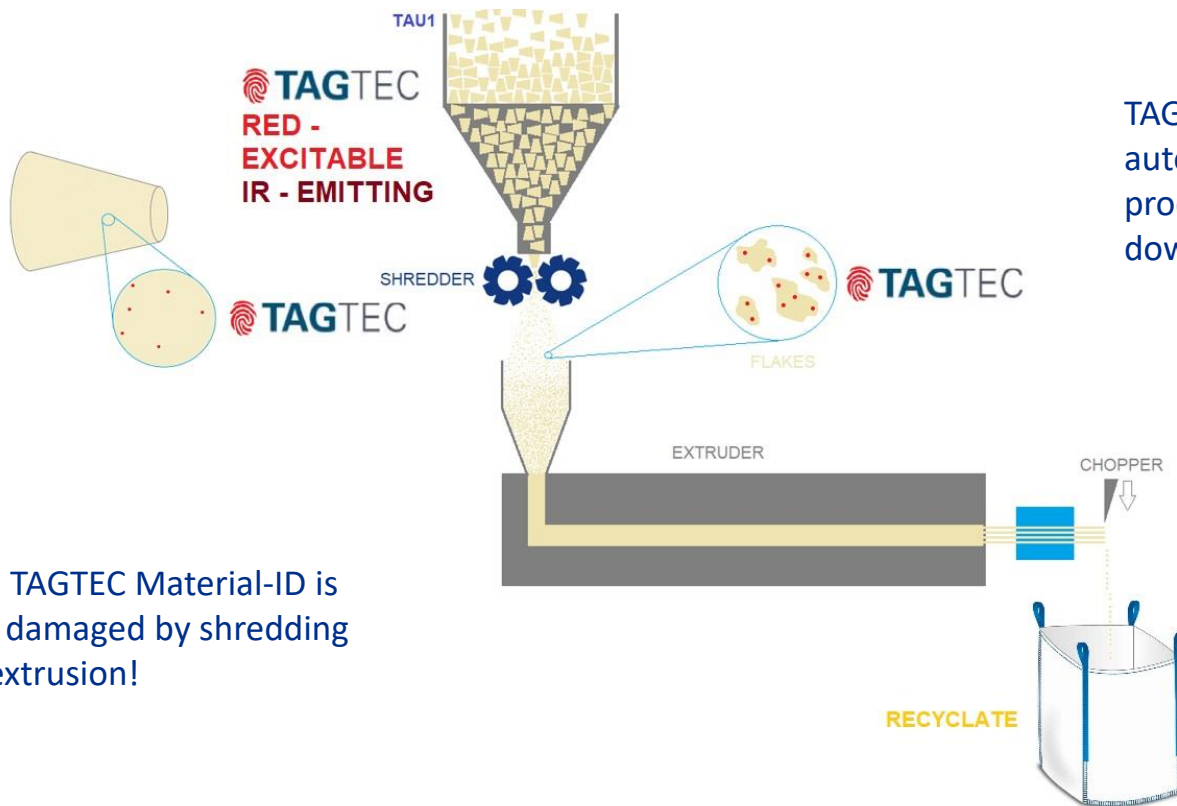
CONVEYOR BELT

Sorting



TAGTEC Material-ID enables automated sorting of plastic parts and packaging. TAGTEC detectors can be combined with NIR sensors to distinguish plastic types and color sensors.

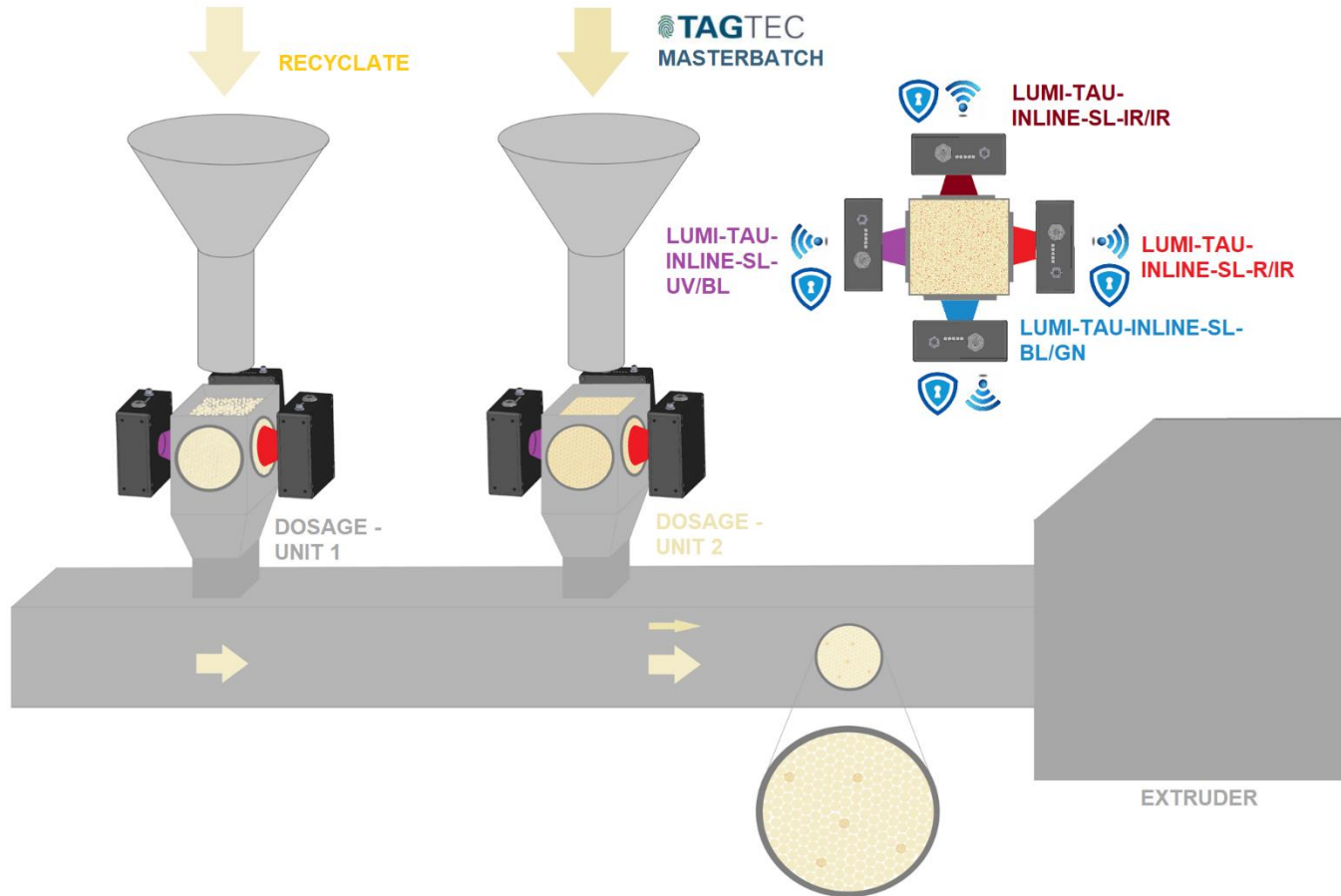
TACTEC IN THE RECYCLING LOOP – RECYCLING GRANULES



TAGTEC-coded materials can be automatically sorted and processed into recycled pellets in a downstream process.

The TAGTEC Material-ID is not damaged by shredding or extrusion!

TACTEC IN THE RECYCLING LOOP – RETURN TO THE PRODUCT STREAM



TAGTEC – ONE TECHNOLOGY, COUNTLESS POSSIBILITIES



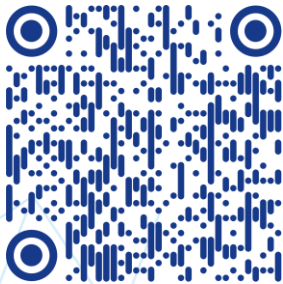
Product authentication and identification with the TAGTEC marker-based system offers numerous application possibilities:

- Separation and error-free separation of recycled material
- Optimization, documentation and automation of product processes
- Protection against counterfeiting
- Function control
- Process control
- Dosage control
- Material control and material identification

TAGTEC offers security, sustainability and transparent information for your products throughout the entire supply chain. Tailored to your needs.



**TALK TO US,
WE ARE GLAD TO BE THERE FOR YOU.**



Sensor Instruments
Entwicklungs- und Vertriebs GmbH
Schlinding 15
D-94169 Thurmansbang

Your contact:

Helmut Löw

Office +49 8544 97 19-0

Mobile +49 151 22 600 782

E-Mail h.loew@sensorinstruments.de

www.sensorinstruments.de

Back-up Slides

TAGTEC – BASIC SYSTEM VARIANTS



System variant:	UV-A/VIS	VIS/VIS	VIS/NIR	NIR/NIR
TAGTEC characteristics: (depending on taggant type) <i>Excitation</i> → <i>Emission</i>	$d_{50} \sim 5\mu\text{m} - 30\mu\text{m}$, inorganic taggant, insensitive to light & robust against high temperatures <i>UV-A</i> → <i>VIS</i>	$d_{50} \sim 5\mu\text{m} - 20\mu\text{m}$, inorganic taggant, insensitive to light & robust against high temperatures <i>BLUE</i> → <i>YELLOW, ORANGE, RED</i> <i>GREEN</i> → <i>ORANGE, RED</i>	$d_{50} \sim 5\mu\text{m} - 20\mu\text{m}$, inorganic taggant, insensitive to light & robust against high temperatures <i>BLUE, RED</i> → <i>NIR</i>	$d_{50} \sim 2\mu\text{m} - 20\mu\text{m}$, inorganic taggant, insensitive to light & robust against high temperatures <i>NIR</i> → <i>NIR</i>
Main Detection Mechanism:	Fluorescence measurement, incl. color differentiation. STAR coding/decoding TAU measurement	Fluorescence measurement, incl. color differentiation. STAR coding/decoding.	Fluorescence measurement, fluorescence particle density, TAU measurement.	TAU measurement.
Application:	Material-ID for authentication, process control, recycling and lot identification. Product-ID for track & trace	Material-ID for authentication, process control, recycling and lot identification. Product-ID for track & trace.	Material-ID for authentication, process control, recycling and lot identification.	Material-ID for authentication, process control, recycling and lot identification.
Security level:	medium - forensic	medium - forensic	high – very high	high – very high
Limit of detection:	ppm	ppm	ppm	ppm
Detector type:	LUMI-STAR-MOBILE-UV/BL, LUMI-STAR-INLINE-UV/BL, SPECTRO-1-...-UV/BL, SPECTRO-3-...-UV/BL LUMI-TAU-MOBILE-UV/yy, LUMI-TAU-INLINE-UV/yy.	LUMI-STAR-MOBILE-xx/yy, LUMI-STAR-INLINE-xx/yy, SPECTRO-1-...-BL/YL, SPRETRO-3-...-BL/YL.	SPECTRO-1-xx-x/IR, LUMI-STAR-INLINE-x/IR, LUMI-TAU-MOBILE-x/IR, LUMI-TAU-INLINE-x/IR.	LUMI-TAU-MOBILE-IR/IR, LUMI-TAU-INLINE-IR/IR.

Note: The choice of the TAGTEC system variant is application dependent. Basic TAGTEC system variants can be used in combination, as they do not influence each other.