

Technical Glossary

3D Integrated Design Approach (3D-I)- this is a layerwise method of designing 3D products which is developed in SMARTLAM. The *functional elements* of the product are achieved by the integration of *features* across several layers.

Accuracy- see *Precision, Accuracy, Repeatability, Tolerance*

Alignment Marks- applied to foils in order to align during bonding

Alignment- matching of position and orientation of a sheet or a semi-finished product with an additional sheet (see also *stacking*). The horizontal planes (linear in x, y, rotational) of the sheets are aligned based on alignment marks captured with the vision system.

Assembly- combining parts using handling and joining technologies

Attrition Cost- or “Mask Wear Cost” is the cost rate due to the use of the mask in the laser process which must be replaced regularly.

Auxiliary Area- area outside of the product area which is used for supporting processes, e.g. fixing.

Base Sheet- bottommost sheet which is processed first. The rest of the sheets are joined onto that sheet.

BIG- *Business Interest Group*: A group of comprising sector specific SMEs and large companies and industrial associations with the fitting business cases and aims and expertise to be able to absorb, adapt and exploit SMARTLAM S+T deliverables into new market areas

Boundary Conditions- For a set problem, a fixed scope is required to find an answer. Boundary conditions set the extreme parameters of the scope so that a solution can be found.

Bonding- a term used in SMARTLAM in two contexts:

1. Generic term summarizing the technologies available for force fit or form fit bonding of two SMARTLAM layers as part of the stacking process

2. Generic term summarizing different methods to connect a discrete part (e.g. the DLED bare die) → The use of this this second context is to be avoided in the future. The terms adhesive or glue should be used in such cases.

Burden Rate- Is the cost per time of using equipment and it includes the depreciation of the cost of the equipment and the machine hour rate to operate

CAD-feature- standard CAD terminology (this is a separate term to *Feature*)

Channel- a groove in a polymer film. For SMARTLAM this refers to the passage through which fluid in the microfluidic devices flows, or similar features.

Coating- (optional) Process cell in SMARTLAM required for application of either hotmelts for lamination or other absorption material for laser welding

Competence- a manufacturing capability for a single set of technical aspects including material, processing technology, and size. Competences are stored in *MinaBase* and include specific process parameters if known. An example competence that has 5 technical aspects is a 100 μm deep hole of radius 5 μm in PMMA produced using the Excimer laser with a surface roughness of 1 μm .

Complex Interface- interface between process cells and superordinate control and supply. It is based on three elements:

- 1. Control interface-** A control interface connects a process cell to the superordinate control system. This includes information about the used communication (field)bus, as well as the communication protocol. The protocol defines how a process cell communicates with the control system (e.g. structure of messages, synchronous or asynchronous communication).
- 2. Mechanical interface-** Describes the interconnection of a process cell to the SMARTLAM system from a mechanical point of view ("docking system" for a process cell to enable integration into the work piece transfer system)
- 3. Supply interface-** Describes the means of supply required by a process cell to be operated and how the process cell is connected to the supply sources (special types of connectors to gas supply, power supply, special liquids and material supplies)

Component Module Model- redundant term previously used to indicate *Process Cell Model*

Configuration- the physical layout of the SMARTLAM *process cells*

Configuration Tool- a tool that is used to identify the optimal configuration of a SMARTLAM system

Control System- Superordinate system that coordinates the SMARTLAM process cells to realise desired process behaviour. Once a process chain shall be executed, the control system distributes *tasks* to the corresponding process cells and receives processing results (e.g. measurement values, execution confirmations, status messages). The control system is tightly connected to the *SmartFactory* toolkit where it receives the control *recipes* from. Moreover, the execution feedback data is sent back to the SmartFactory toolkit for process optimization.

Demonstrator Platform- interchangeable with *demonstrator system*.

Demonstrator Products- the products being used to demonstrate the SMARTLAM methodology

Demonstrator- short for *demonstrator product*.

Demonstrator System- the overall SMARTLAM system used for demonstration purposes

Dummy layer- Substrate without functionality, used as cover layer, membrane or filling material

Feature- the simplest geometrical structure for which there can be a variety of competences contained in *MinaBase* (e.g. blind or through hole). To be differentiated from *CAD-Feature* which has a standard meaning in any CAD package.

Film- thin polymeric material used as raw material for the sheets in SMARTLAM. Sometimes used interchangeably with layer and foil. See also *substrate*.

Finished SMARTLAM Assembly- the finished product(s) in the overall sheet size. A Finished SMARTLAM Assembly sheet may consist of one or more SMARTLAM products

Fixing- temporary joining of aligned sheets (e.g. laser welding in small areas) before the final joining of sheets (e.g. lamination)

Flash- sintering of printed ink using short light impulses.

Foil- interchangeable with *film*

FORTE- (Function Block Runtime Environment): Performs the execution of Function Blocks and complete networks of interconnected Function Blocks (applications). The FORTE (4DIAC Runtime Environment) is a specific implementation of an IEC 61499 compliant runtime environment and supports Windows, Linux and some embedded platforms. In order to ensure flexibility, the runtime is easily extendable to support addition layers for network communication or to interconnect with different software frameworks (ROS, YARP,...).

Functional Element- composition of one or more *features* which can perform device specific functions (e. g. a microsieve composed by and array of micro holes)

Geometry- it has been used for various meanings, most often indicating *feature*. The term should no longer be used without attributing an exact meaning to it.

Generative Manufacturing- not to be confused with additive manufacturing. In SMARTLAM *generative manufacturing* is a generic term for all technologies which do not require the use of a mask, a mould or any other means of shape replication.

Handling System- system to move and orientate parts within the SMARTLAM system. Several different handling systems are integrated, e.g. workpiece carrier handling, sheet handling, discrete part handling.

IEC 61499- An open standard to describe distributed industrial process, measurement and control systems. The programming paradigm is based on *function blocks* which are processed according to an event-driven execution scheme, and eases the development of interoperable, portable, and configurable systems

Interface- see *Complex Interface*

Joining- permanent joining of sheets with technologies such as lamination or laser welding.

Language- this term was used in WP1 to identify the way in which a process cell is described (in SMARTLAM, this does not refer to a programming language). An example is a list of all the information required about a process cell to enable it to be controlled by the overall SMARTLAM system.

Laser- In SMARTLAM three different laser types (modules) are summarised under this keyword according to their respective functions:

- Eximer laser with wavelength in the UV range is used for “cold ablation” (nearly without melting) and is suitable for structuring of features such as channels, through holes, vias and alignment structures.
- Diode laser with wavelength in the NIR range is used for transmission welding of polymers (bonding). This process requires an absorption layer on the interface of the two polymer layers to be bonded.
- CO₂-Laser with wavelength in the IR range is applied as a cutting tool of sheets. This prompted by its high quality focused and powerful beam.

Layer- see *film*

LCC Analysis- (*Life Cycle Costing Analysis*): is an evaluation of the entire cost of a product or service, including energy, materials, production, maintenance, running and recycling costs.

LEAR- (*Legal Entity Appointed Representative*): A legal signatory of each legal entity must appoint one person (the so-called LEAR – Legal Entity Appointed Representative) for being the correspondent towards the Commission on all issues related to the legal status of the entity.

Macro Geometry- Macro-scale geometrical aspects of the overall product (e.g. overall product dimensions)

Material Factor (score)- a method used to rate the manufacturing ability of a material for a specific process.

Maturity (Technology Readiness) - A description or statement of how ready the technology is for a particular requirement, for example, commercial introduction.

Micro Components- discrete parts to be integrated into a SMARTLAM

assembly, e.g. LEDs. (in WP1 this is defined as *Pre-manufactured component*)

MinaBase- web based database system which is the software implementation of the MinaBASE knowledge management methodology. The MinaBase methodology is used for the homogenous characterisation of manufacturing technologies within the domain of Multi-Material Micro Manufacturing.

Module- (not to be confused with *Manufacturing Cell*) can be any functionally independent structure/device within a given manufacturing cell. A manufacturing cell consists of multiple interacting modules. Visual inspection system, laser system and transport rails are typical examples of modules.

Plug & Produce- a methodology to introduce (or remove) a new manufacturing cell into a manufacturing system easily and quickly; the configuration of such a system in SMARTLAM is provided by the Configuration Tool.

Pocket- a flat-bottomed (blind) trench or hole machined onto the surface of a given workpiece

Position pins- used for alignment of the layer for bonding. The pins fit into holes in the polymer films

Precision, Accuracy, Repeatability, Tolerance

1. Accuracy- a **qualitative** term which describes how close a set of manufactured features match the designed size and shape
2. Precision- the spread of measurements performed under identical conditions.
3. Repeatability- equivalent to *Precision*
4. Tolerance- a **quantitative** term which describes how close a set of manufactured features match the designed size and shape

Pre-manufactured component- a component that is inserted into a SMARTLAM product (e.g. an LED) rather than manufactured by a process cell

Prestructured Polymer- a polymer film with a surface modification for a specific function

Printed Thickness- height of (z) of printed layer/feature. See also printed width.

Printed Width- width (x or y direction) of printed layer/feature.

Printing- In SMARTLAM this refers to aerosol jet printing.

Process (Technology)- The technology that is used for the machining of a specific geometry in SMARTLAM (e. g laser milling or aerosol jet printing)

Process Cell- Independent unit within the SMARTLAM platform, linked to other cells through mechanical (transfer system), electrical, fluidic and software interfaces. Each SMARTLAM cell basically consists of a frame, housing, positioning system, control system and process module. All cells can, but do not have to be equipped with a vision system. The following cells have been identified so far:

- Feeder (optional)
- Welding unit (IR-Laser)
- Coating (optional)
- Laminator (Flatbed laminator)
- Assembly unit
- Printer
- Structuring (Eximer laser)
- Separator (CO₂ Laser, optional)
- Inspection

See also *Process Component*.

Process Cell Model Model to describe a process component (component module) from the “control”, “supply”, “mechanical”, “electrical” and “economical” viewpoints. It contains the information described by the interfaces listed in the section of WP4. Component Module models serve as information base for SMARTLAM process module and overall system development.

Process Chain- the order in which different process technologies are applied to manufacture the final product

Process Component- interchangeable with *Process Cell*

Process Module- redundant term previously used to indicate *Process Cell*

Process Parameter- a parameter which is normally controlled by the machine

operator (SmartFactory toolkit) and characterises the specific process (e.g. wavelength or power of a laser system)

Process Sequence- another phrase for Process Chain

Process Step- not to be confused with SMARTLAM *cell*. A process step represents an operation (e.g. *stacking*) which might consist of several tasks performed by different cells. For example *stacking* is a step which consists of alignment, fixturing and lamination.

Product Area- part of the sheet which is processed to build the product

Profitability - Is a financial term describing the qualitative or quantitative evaluation of product or service selling pricing, compared to manufacturing or production costs.

PUDF- *Plan for the Use and Dissemination of Foreground*: Proposals will have to contain a "plan for the use and dissemination of foreground" to show that the knowledge generated will be taken through to application. This plan will be updated as a part of the periodic and final reports to reflect the evolving intentions for the protection, use and dissemination of the knowledge generated under the project

Recipe- the order of all of the manufacturing steps. The overall manufacturing process (Process Chain) is represented as a Task Tree structure, which can be executed by the SMARTLAM control system.

Repeatability- see *Precision, Accuracy, Repeatability, Tolerance*

Separation- dividing a finished SMARTLAM assembly into SMARTLAM products in the case of multiple products manufactured on the area of one sheet

Sheet Stack- stack of sheets as material input of the SMARTLAM system.

Sheet- thin polymeric material cut to defined size as base for SMARTLAM products, e.g. 150 x 150 mm.

Sintering- thermal treatment of printed structures. Typically this is accomplished via projecting energy into the printed structure via oven, laser (continuous wave or pulsed), light (continuous wave or pulsed/flash), DC

electrical or AC electrical methods. E.g. IR-Laser, Oven, Flash.

SmartFactory toolkit- a software toolkit which is used to configure the SMARTLAM system. It consists of a code generation tool, a simulation environment and a runtime environment for IEC 61499 conform control applications. The toolkit generates Recipes based on the chosen Process Chains and is capable of distributing tasks to the Process Components. The toolchain moreover provides feedback data to the MinaBase

SMARTLAM Cell – Interchangeable with *Process Cell*

SMARTLAM Platform- a conceptual overall SMARTLAM machine

SMARTLAM Product- finished product after optional separating

SMARTLAM System- manufacturing system consisting of several process cells, superordinate control system and supply.

Smart (functionalised) layer- Film (foil) with added functionality resulting from printing, coating and/or structuring step. Smart layers may consist of one or more functionalisations per film surface (top and bottom)

SMARTLAM Technologies- a set of SMARTLAM cells, which also includes “service cells” such as characterisation, feeding, etc.

Stacking- this is the process step describing the layer by layer bonding of polymer films (can but does not have to be done together with the alignment). In SMARTLAM stacking sequences consist of a film preparation task (application of position markers plus film handling), an alignment task and the subsequent bonding task (lamination or laser welding).

Structuring- machining that involves removal or sublimation of material (see *laser*).

Substrate- the material that may be machined. In SMARTLAM this is a polymer sheet. Substrates can be either functionalised to become *smart layers* or left unprocessed and used as *dummy layers*.

Supporting Equipment- the equipment used for pre- or post-processing such as cleaning or deburring.

Sustainability- requires the reconciliation of environmental, social equity and economic demands. Sustainability interfaces with economics through the

social and environmental consequences of economic activity. Sustainability economics involves [ecological economics](#) where social aspects including cultural, health-related and monetary/financial aspects are integrated.

SWOT Analysis- is a structured [planning](#) method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a [project](#) or in a [business](#) venture. A SWOT analysis can be carried out for a product, place, industry or person. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective.

System Integrator- the organisation that physically builds the demonstrator systems by integrating the individually developed process cells.

Task- A single operation (e.g. pick up polymer film, laser weld two films) in an overall *process step* (e.g. *stacking*).

Task Tree- A n-ary tree structure, also referred as “forest”, which is used to define the execution sequence of a collection of tasks (for one *process step*). The execution-scheme of a *task tree* is based on standardized traversing-concepts.

Technical Aspect- are individual parameters in MinaBase to model materials, machines, technologies and more. Examples are material type, processing technology, and hole size.

Technology Robustness- is a description or statement relating to the capability or readiness of a particular technology

Thin film segments- parts of film clearly smaller than the sheets (it was under discussion for use as intelligent layers)

Tolerance- see *Precision, Accuracy, Repeatability, Tolerance*

UML Diagrams- standardised, general-purpose modelling tools in the field of software engineering. The Unified Modelling Language (UML) includes a set of graphic notation techniques to create visual models of object-oriented software-intensive systems

Vision System- System to perform visual inspection for quality control as well as to enable positioning control, which is required to update target

coordinates of processes, based on the current position of the work piece on the carrier

Waffle Pack- tray containing loose parts in cavities

Welding module- see *laser*

Workpiece Carrier- device put onto a transfer system for transferring sheets or (semi-)finished SMARTLAM assemblies between the process modules.