milestones in composites

The Fiber Patch Placement Specialists

flexible automation platform

multi-material lay-up

self-corrective inline quality control

digital development services

CAD-FEM-CAM software

complex 3D shapes

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Revolutionizing composites with Fiber Patch Placement

Composites Manufacturing
The demand for lightweight structures mandates the use of fiber composites, offering a higher specific strength and stiffness than conventional materials. But labor-intensive, manual production processes increase production costs and limit scalability. Available automation solutions for manufacturers are often very expensive and inflexible when product changes need to be implemented.

Challenges of conventional production methods
- High scrap rates
- Slow lay-up rates
- Unflexible & expensive equipment
- High production cost
- No automated solutions for complex 3D shapes and integrated multi-material lay-up

Fiber Patch Placement
Fiber Patch Placement (FPP) bridges the gap between productivity, flexibility and costs. It offers efficiency even at low volumes through flexible, scalable automation. Adapted to the size and complexity of a component, the technology works additively in “sensible increments”, so-called fiber patches. This enables automation for complex 3D shapes, multi-material laminates and locally load-adjusted fiber designs, resulting in efficient lightweight solutions with a remarkably improved performance-to-weight ratio.

Benefits of additive Fiber Patch Placement
- Flexible automation platform: One system, multiple parts
- Quick & economical product changes
- Easy-to-use design and production software
- Multi-material lay-up (carbon, glass, adhesives, etc.)
- Very low scrap rate
- Self-corrective process control & quality inspection
Composites 4.0 – the Cevotec portfolio

**SAMBA Series** – automated production systems
- Production platform for complex fiber lay-ups
- Automated direct 3D fiber placement
- Customizable robot and machine configurations
- Adjusted to component size & complexity

**ARTIST STUDIO** – CAE software platform
- Virtual product development platform for patch- and tape-based technologies
- Designed for use with SAMBA systems
- Laminate design and offline robot programming
- Plug-in for commercial FE-software for simulation of mechanical laminate properties

**cevoLab** – customizing patch technology
- Individual application development
- FE-simulation and laminate optimization
- Product development & prototyping
- Small-scale series production
- Patch grippers tailored to your application

**cevoServices** – support, training, maintenance, consumables
- Comprehensive design & production support
- Training and consulting for engineering teams
- Regular preventive maintenance for highest availability
- Patch gripper refurbishments
- Customized carbon fiber tape
SAMBA Series – automated 3D fiber lay-up production platforms

SAMBA Series – automated 3D fiber lay-up platforms

The Fiber Patch Placement systems of the SAMBA Series are your flexible, automated production platforms for challenging fiber lay-ups. Fully automated and programmed with ARTIST STUDIO software and equipped with a fast-mounting tool interface, SAMBA systems act as your economical production platform for a variety of parts.

Customized to your part size and materials

Sizes: Highly scalable. It is additive manufacturing in “sensible increments”, depending on your component. We implement FPP technology with small patches of 20 mm x 40 mm up to large patches of 200 mm x 300 mm and beyond.

Materials: SAMBA Series platforms work with a range of different dry-fiber and thermoset prepreg materials of all major material suppliers, covering areal weights of 80 gsm to 300 gsm and beyond.

Customization: Speak to us for an individual implementation of Fiber Patch Placement. Together with our partner Baumann Automation, we provide turnkey production lines in any dimension you require.

SAMBA Scale

Key features

- Scaled configuration for high fiber throughput
- Patch grippers in DIN-A5 and DIN-A4 sizes
- Fiber throughput ~ 15 kg/h per feeding unit
- Integrated gripper station for changing gripper sizes in process
- Multitude of sensors for comprehensive process monitoring

Application focus

- Complex 3D shapes of large to medium-size
- High material throughput requirements
- Industry-specific examples
- Automotive: Battery boxes, roof rails, window frames, hoods, spoilers
- Aerospace: 90°/±45° layers in spars, battery boxes, panel reinforcements

SAMBA Scale Line

- Line configuration with high throughput of > 100 kg/h

SAMBA Step

Key features

- R&D-focused, low-investment patch placement system
- Flexible degree of automation
- Individual robot configuration, up to 12 axes
- Fiber throughput ~ 500 g/h
- Fast and easy tool change system
- Optional: Sensors to monitor production process

Application focus

- Prototyping and product development in R&D departments, institutes and universities

End-to-end automation for dry fiber preforming

After fiber lay-up, an additional robot detaches the inherently stable laminates automatically from the tool and moves them to the next processing step.

SAMBA Multi

Key features

- Multiple feeding units for parallel material processing
- Automated change of tapes
- Advanced sensor-based, self-corrective process control

Detailed configuration example next page

SAMBA Pro

Key features

- Fast SCARA robot for fiber placement
- Precise 6-axis robot for tool manipulation
- Smaller patch sizes adapted to geometrical complexity
- Fiber throughput ~ 2-3 kg/h with thin ply tape
- Fast and easy tool change system
- Multitude of sensors for comprehensive process monitoring
- Optional: Integrated gripper station for changing gripper sizes in process

Application focus

- Flexible batch production of multiple products
- Medium-sized to smaller parts of high geometrical complexity
- Reinforcements of larger parts

Industry-specific examples

- Aerospace: Window frames, reinforcement patches
- Automotive: Spoilers, decoration parts, A/B/C-pillar structures
- Medical: Prosthetics, orthotics
- Sports: Snowboard and ski reinforcements

SAMBA Multi

Key features

- End-to-end automation for dry fiber preforming

After fiber lay-up, an additional robot detaches the inherently stable laminates automatically from the tool and moves them to the next processing step.
SAMBA Multi – automated multi-material 3D fiber lay-up

SAMBA Multi - configuration example

Key features
- Multiple feeding units for parallel processing of up to 4 different materials
- Automated change of tapes
- Direct fiber lay-up of complex 3D & 2D laminates
- 6-axis robot with large reach for fiber placement
- Individual tool manipulators
- Linear rail for production of large components (optional)
- Patch grippers scaled to DIN-A5 and DIN-A4 sizes
- Integrated gripper station for changing gripper sizes in process
- Cooled material storage for prepreg material
- Seamless integration of machine in ARTIST STUDIO software
- Multitude of sensors for comprehensive process monitoring
- Seamless quality protocol of process parameters
- 100% in-process, self-corrective tape quality inspection & position accuracy control
- High accuracy of fiber deposition

Process specifications
- Tape configuration:
  - 50 mm – 200 mm
  - 100 mm – 300 mm
- Min/Max patch length:
  - 4 s
  - ~15 kg/h per unit
- Spool change:
  - < 6 min
- Tape accuracy inspection:
  - < 0.25 mm
- Patch cutting repeatability:
  - < 0.5 mm
- Placement accuracy:
  - < 1 mm
- Vision inspection:
  - 12 MP camera resolution
- Cutting:
  - Ultrasonic knife
- Compaction force & momentum control:
  - Up to 2,800 N und 120 Nm
- Patch heating:
  - Infrared heating up to 200°C
- Patch surface temperature control:
  - < 5°C
- Material storage cooling:
  - Minimum 8°C
- Backing firm:
  - Rewinding unit
- Spool diameter:
  - 450 mm
- Tape volume per spool:
  - 400 m - 600 m
- Magnetic break
- Advanced production management

Options
- Photonic heating for carbon material:
- Automated patch gripper exchange rig:
- Laser cutting device:
- Dust and gas suction:
- Spool diameter:
- Tension controlled tape feeding:
- Material traceability:

Software support
- Patch & tape laminate design software:
- Offline programming software:
- FEA simulation software:

Materials
- Dry carbon fiber:
  - 40 gsm – 300 gsm
- Dry glass fiber:
  - 40 gsm – 300 gsm
- Dry aramid fiber:
  - On request
- Other technical fibers:
  - 150 gsm – 200 gsm
- Thermoset carbon prepreg:
  - 40 gsm – 300 gsm
- Thermoset glass prepreg:
  - 40 gsm – 300 gsm
- Thermoset adhesive film:
  - 100 gsm – 200 gsm
- Thermoset metal fabric:

Application focus
- Large, complex 3D / 2D components
- Multi-material placement
- Sandwich core placement

Industry-specific examples
- Aerospace: Control surfaces, nacelle structures, radomes, battery boxes, bulkheads
- Automotive: Fiber-metal reinforcement

Key advantages
- 24/7 fully automated series production of complex 3D geometries
- Combination of different materials or tape geometries within one part
- High productivity, especially on strongly curved surfaces
- Very low material scrap, weight and cost through additive manufacturing
- High stiffness and strength of parts through load-adjusted fiber orientation
- In-process, self-regulatory quality inspection with full documentation
Focus industries
Aerospace | Automotive | Medical | Sports & other

Strategic partners
Strong partners share our vision, support us and work jointly with us towards a better future!

Cevotec representative in North America:
Composite Automation
http://www.compositeautomation.com

References
Premier OEM, manufacturers and institutes develop innovative composite solutions with us. Among them:
ARTIST STUDIO (CAD-FEM-CAM)
ARTIST STUDIO is the perfect tool for your digital product development and robot offline programming. The software creates an optimized patch laminate and generates the corresponding machine data for the SAMBA systems. ARTIST STUDIO combines multiple, perfectly aligned modules and plug-ins for your product and process development.

Advantages
- Stand-alone CAD-CAM software with plug-in for commercial FEA-software
- Fast and continuous process from CAD to machine data on a single platform
- Ease of use of the software through intuitive application and interface logic
- Import of all common CAD file formats

Tape Artist (CAD for AFP) provides all functions for efficient laminate design for AFP processes. Laminate planning for AFP can also be combined with FPP to create hybrid AFP-FPP laminates. Seamlessly integrated into the software platform.

Advantages for fast laminate generation
- Generate AFP multiaxial laminates
- Create AFP-FPP laminates in combination with PATCH ARTIST functionalities
- Reduce scrap with different lay-up strategies

Patch Artist (CAD for FPP) is the patch laminate design module. Its user interface is designed to easily define patch zones on imported CAD surfaces, as well as layer size, layer orientations, layer thickness, tape width and patch length.

The patch zone boundaries and layer orientations can be constructed as splines within a CAD-system and afterwards imported directly in PATCH ARTIST.

Advantages for fast laminate generation
- High performance laminates & reinforcements with direction-variable fiber orientation
- Excellent mechanical properties through an integrated algorithm for optimizing patch overlaps
- Optional, simple manual laminate modification by intuitive user interface logic

Motion Artist (CAM for FPP) enables you to program the SAMBA robots offline in a fully automated way. With that the preparation time for production is significantly shortened and the built-in collision detection as well as the visual process simulation also increase the safety on your shop floor.

Advantages for fast laminate generation
- Fast creation of machine data through offline robot programming
- Efficient manufacturing process through optimized movement of robot axes
- Reduction of production preparation time through integrated process simulation
- Increase of production safety with integrated collision detection

Motion Artist (CAM for AFP) enables you to program offline the robot in a fully automated way. With that the production preparation time is significantly reduced and the integrated collision detection as well as the process simulation also increase the safety on your shop floor.

Advantages for robot programming and production preparation
- Fast creation of machine data through offline robot programming
- Efficient manufacturing process through optimized movement of robot axes
- Reduction of production preparation time through integrated process simulation
- Increase of production safety with integrated collision detection

Artist Studio plug-in for FEA-software automatically generates a detailed FE-model of the patch laminate within the FE preprocessor HyperMesh™, based on the data defined in PATCH ARTIST regarding geometry, position and orientation of the patches. The contour of each individual patch is used to model fiber orientations and overlap areas.

Advantages for automated patch laminate modeling
- Fast modeling and evaluation of patch laminates
- Different analysis types supported by automated modeling approaches
- Improvement of the out-of-plane deformation behavior using thick shell elements
ARTIST STUDIO – specification

Laminate design (CAD)
- Interface: Import of STEP, IGES, STL, CATPart
  Export of laminate (STEP) for FE-modeling
- Laminate: Layer definition with specific laminate properties and constraints
  Different lay-up strategies at boundaries
  (reducing scrap, constant layer thickness)
- Curve planning: Parallel curves based on user defined master curve
  Curves along user-defined fiber orientation
- Optimization: Patch overlap optimization
- Visualization: CAD, systems, surface normals
  Curves, curve orientation and curvature (in-plane, out-of-plane)
  Individual patch overlap quality
- Documentation: Browser-based documentation with tutorials

Robot offline programming (CAM)
- Robot kinematics: 4 or 6 axis robots, robot on linear axis
  Robot-to-robot interaction logic
  Robot-assisted, linear axis, rotational axis
- Mold mount point: Coordinate-based position and orientation
  Robot-to-robot positioning, tool positioning
  Point-to-Point (PTP), linear
- Caliberation: Robot movements with consideration of
  Axis limits
  - Robot range
  - Singularities
  - Collision detection
- Optimization: using multiprocessing
- Visualization: Robot movements, collisions, laminate
- Reporting: Material consumption, production time
- Interface: Updates of changes in laminate design
  Export of machine data (i.e. xml)
- Documentation: Browser-based software documentation with tutorials

Plug-in for FE-modeling (FEA)
- Availability: FEA preprocessor HyperMesh™ Release-Version 2017 and up
- Accessibility: Menu-bar with subsequent dialogue-based processes
- Interface: Import of laminate from ARTIST STUDIO platform
- Properties: Automated modeling of patches, fiber orientation, thickness, patch overlaps
  Different modeling methods (shell/solid) and strategies for patch laminates
- Documentation: Browser-based software documentation with tutorials
cevoGripper – adapting to complexity

Your key to a fast & automated lay-up process for complex shapes is our form-flexible patch gripper. The gripper is available in tailored sizes to perfectly match your product.

The gripper adapts to the most complex surfaces. Even across 90° angles and biaxially curved surfaces, patches are placed precisely and without draping effects.

Application development services
We develop your application with Fiber Patch Placement technology jointly with you. Working with our engineering experts, you can explore, test and trial patch technology for your products risk-free. Our comprehensive services range from initial planning and construction to finished prototypes produced in our cevoLab.

Configuration
- Available in sizes from 30 mm x 60 mm up to 300 mm x 1000 mm
- Automated quick-mount device for fast and easy gripper changing on-the-fly
- Anodized, precisely machined aluminum baseplates
- High mass-flow vacuum stream, powered by pressured air
- Customized body to meet specific compaction requirements
- Customized heating field suitable for heat-activated binder
- Optional: Active deformation capabilities for concave surfaces

Prototyping & small series production
No matter if you require only a few prototypes for testing in your development process or you are looking to flexibly source small batches of series products - we produce your laminates. Leveraging the latest Fiber Patch Placement equipment in our cevoLab, we offer FPP-as-a-service to support your R&D and production strategy.

Customized SAMBA & grippers
Based on the results of the application development, we can design a SAMBA system tailored to your needs. Together with our partner Baumann Automation, we also provide turnkey production lines with automated interfaces to your existing equipment. Of course, our patch grippers are also adapted to your individual requirements.
Fiber Patch Placement – enabling manufacturers to produce complex composites in high volume and superior quality

Fiber Patch Placement is the additive manufacturing technology for the automated production of geometrically complex fiber composites and curvilinear reinforcements. It enables a new degree of freedom in automated fiber deposition for complex shapes and allows for true multi-material lay-up within one system. Defined patches are automatically cut from a tape and precisely placed by two robots and a flexible patch gripper. Your component is built up additively, flexibly and in a completely automated manner.

Additive manufacturing
Patch technology is additive manufacturing in sensible increments, called patches. As patch sizes adjust to the size and complexity of the component, it provides the speed for mass-market applications while featuring all benefits unique to additive manufacturing such as high flexibility and superior material efficiency.

Automation platform for digital manufacturing
Similar to 3D printing, all components are digitally developed in ARTIST STUDIO software. This includes the design and the offline programming of the production system. Patch laminates can also be imported into FEM software for structural analysis. The SAMBA systems are designed for fast and easy product changes and handling multiple materials for an efficient fiber deposition on complex 3D shapes.

Your benefits
- Self-corrective, in-process quality inspection
- Multi-material lay-up capability (e.g. carbon-, glass fiber, adhesives, dry, prepreg)
- Up to 50% less material consumption, production time and cost
- Flexible automation platform: One system produces multiple parts

Efficient & fast processes
Compared to conventional composite processes, Fiber Patch Placement cuts the time from CAD to prototype significantly. Taking nesting, cutting and kitting out of the process, your recurring production cycle is significantly shortened and simplified. On top of that, production scrap is reduced to less than 10%. That’s efficiency that inspires.

Fiber Patch Placement

1. Feed carbon fiber tape
2. Cut carbon fiber tape into patches
3. Inspect fiber patch quality
4. Pick up patch, check patch position
5. Position patch on 3D form tool

Optimized performance
Patches perfectly align to curvilinear load paths. Therefore, patch technology maximizes the performance of your parts, no matter if the basis is glass fiber or carbon fiber. Stiffness and strength increase up to 150% compared to conventional lay-ups.