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FACTORY ECOPLAST

DEVELOPMENT AND CHARACTERISATION OF ECO- FRIENDLY THERMOPLASTICS

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- A new type of concrete will lead to lighter, better designed structures
Last: 01.2007
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- Developing eco-friendly composite materials
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- Feeding the world more
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Success story

1. INTRODUCTION
2. INJECTION MOULDING TECHNOLOGY
3. INJECTION MOULDING OF WOOD-PLASTICS
COMPOSITE (WPC)
4. INJECTION MOULDING OF INDUSTRIAL
PRODUCTS
5. CONCLUSION

1. INTRODUCTION

Project consortium



Project coordinator

- ISOKON / ISOSPORT GmbH - Slovenia

Project partners

- TECOS, Slovenian Tool and Die Development Centre, Slovenia
- FS, Faculty of Mechanical Engineering, University of Ljubljana, Slovenia
- PIEP, Department for Innovation in Polymer Engineering, University of Guimaraes, Portugal
- FSB, Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb, Croatia
- TVK:, Tiszai Vegyi kombinát Rt, Hungary
- BUTE: Budapest University of Technology and Economics, Hungary
- RS – Rettenmaier & Soehne GmbH + co, Germany
- INTELASTICO Industrias Técnicas de Plásticos, SA, Portugal

Challenges or reality for the new millennium



- The oil supply is getting smaller every day and the pressure to become more independent from oil derivatives is at the all time high, therefore there are multiple reasons to maximize the usage of renewable resources.
- On the other hand we have enough natural resources like wood, flax, hemp, jute...
- One of the very interesting areas of research in this field is in combining natural fibers with thermoplastics.

Price is not the only reason for wood plastic composites

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- Environmental impact
 - Kyoto CO2 emissions
 - Emission trading between countries
 - Waste directives in EU
 - Increased taxes
 - Recycling



Biopolymers

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- Polymers which include some type of natural material in structure
- One of the biggest new areas of research
- Synergism between the components results in a new material that is better than the individual components
- Becoming more independent from oil derivatives



Natural fibres

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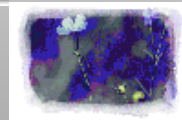
- Advantages of using natural fibres in polymers

- Lower density
- Lower abrasion
- High fill rates are possible < 85 %
- Easy to recycle
- Lower cost



- Type of natural fillers

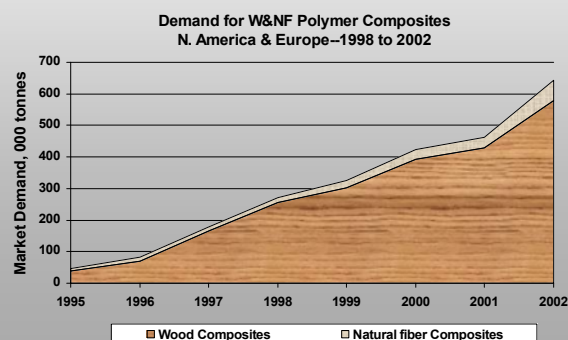
- Wood fibre, powder
- Jute
- Flax
- Hemp
- Rice, coconut



Composite growth in demand since the early 1990s...

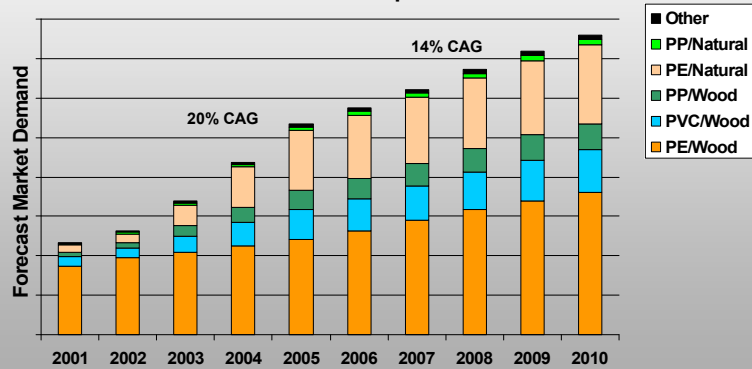
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- European market in 2002: 32 mio €
- Very new market except in automotive
- Rapidly growing is the building sector

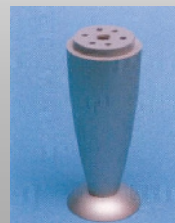
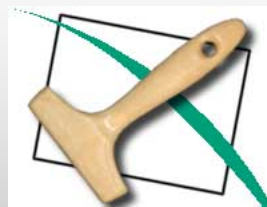


Short term growth
will be 20% a year

Forecast Demand for N&WF Polymer Composites
N. America & Europe--2001 to 2010



Household & office goods



Household & office goods

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Packages & cases

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Beverage boxes



Trashboxes



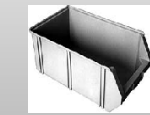
Screw boxes



To select suitable products

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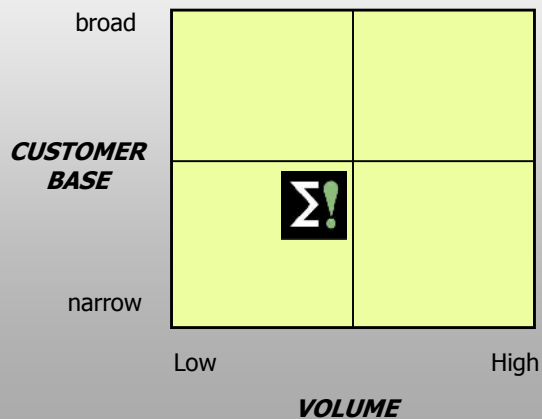
- Office goods
- Screw boxes
- Loudspeakers cases



Project group selection

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- Loudspeaker boxes
- Enhanced acoustic properties > PS



Wood is known for its acoustic properties and usage in musical instruments.



- A lot of speaker boxes are manufactured from injection moulded polymers, we assume that wood PP composite should have better properties.
- Acoustic properties of a material are very simplified defined by:
 - Sound radiation damping
 - Sound wave resistance
 - Internal losses (friction)



The aim of the project



To research rheological properties, compatibility between natural fibers and thermoplastics, injection moulding parameters and possible applications of the compound.

Product selection has to be based on core competencies of wood-polymer compounds:

- increased rigidity
- reduced wear of machine equipment in processing final products
- reduced weight as compared to the mineral fillers
- wood-like character of the product (easily sawn, drilled, ground)
- advantageous price
- acoustic properties

2. INJECTION MOULDING TECHNOLOGY

- Wood and polymer are the main but not the only components in wood-plastic composite. Other additives are also added, such as coupling agents for wood and polymers, lubricants, colorants, UV-stabilizers, flame retardants...
- Wasted wood has special advantages compared to other fillers: cheap in renewable source, guaranteed supply, unique look, low specific density and it is less abrasive than other fillers (i.e. glass).
- Usually 40-60 % of wood is used in the composite, the rest are matrix polymer and additives. The size of wood particles is usually from 0,50 to 1,0 mm. The more complex the product is the smaller the particles must be.

E! goal: From new materials
to new final products



Product ← Injection Molding Machine ← Raw Material
(Find out optimal proces parametrs)

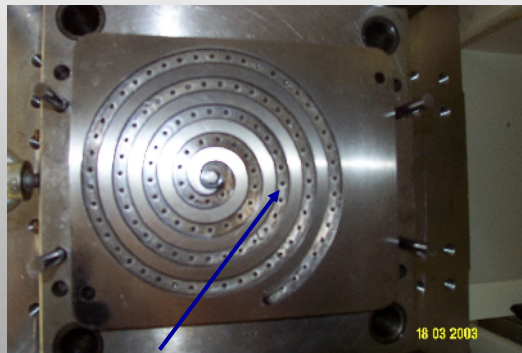


3. INJECTION MOULDING OF WOOD-PLASTICS COMPOSITE (WPC)

Sample for “Flow pattern”

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Mold with spiral



Length of flow

PP+40% wood



Flow lenght = 20 cm

PP only



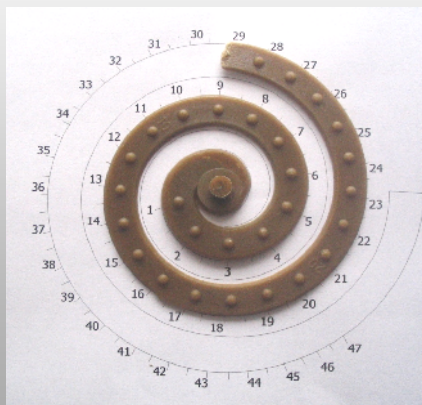
Flow lenght = 33 cm

| | |
|-----------------|----------|
| Injection temp. | 190 °C |
| Max. Pressure | 1300 bar |

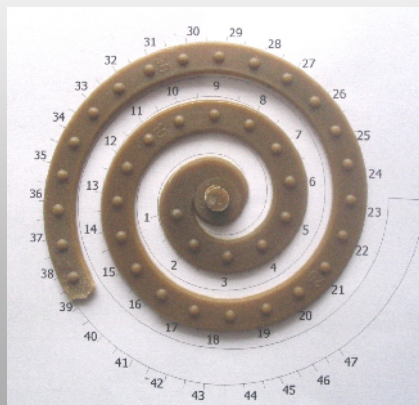
Experimental determination of process parameters

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TVK AKU 8 (40% of wood)



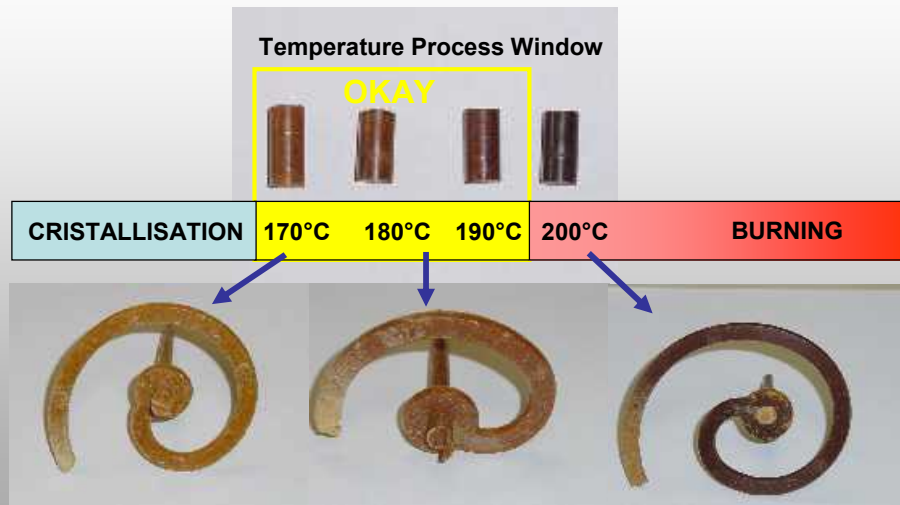
1000 bar



1500 bar

Proces parameters

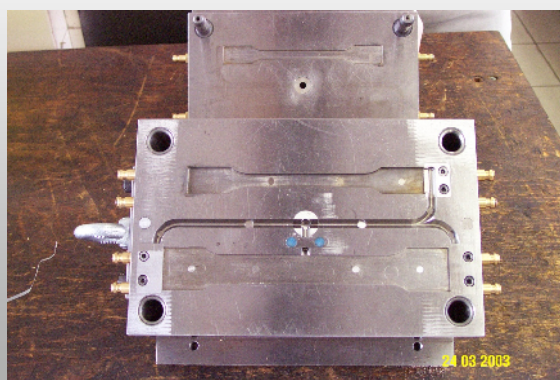
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Samples for tensile tests

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Mold with tensile epruvete ISO 527-1



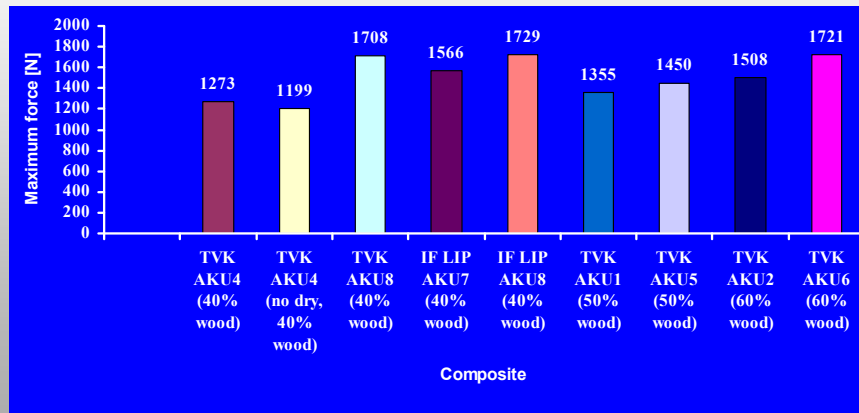
PP + 40% wood



Mechanical properties

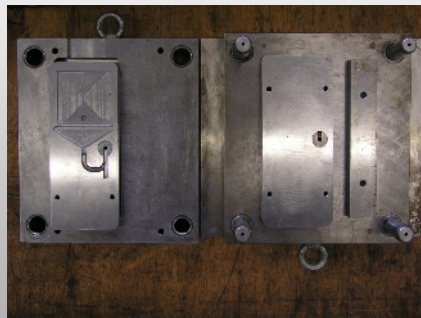
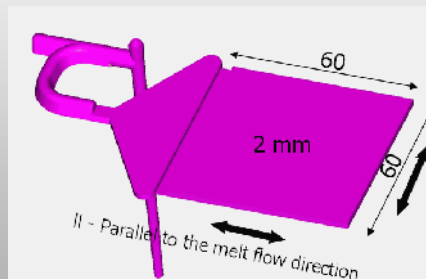
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Maximum force vs Composite

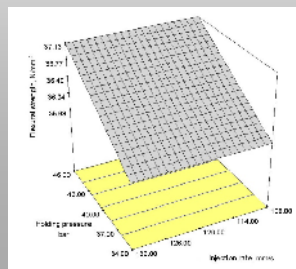
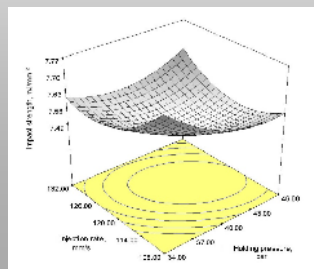
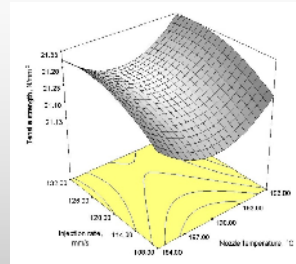
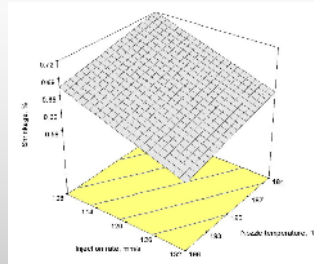


Linear shrinkage standard test specimen ISO 294-4

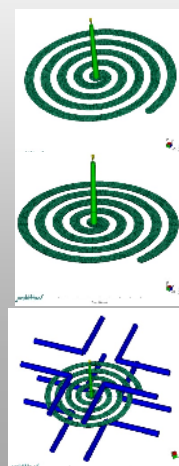
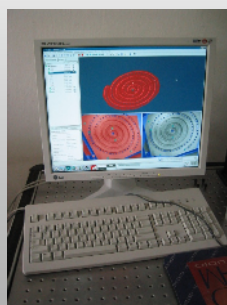
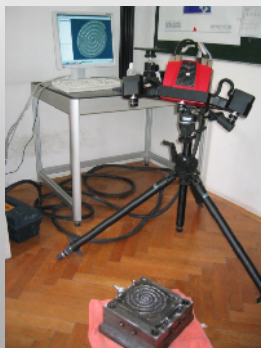
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Mechanical properties of WPC: 61 % PP,
37 % wood fibres, 2 % MAPP coupling agent



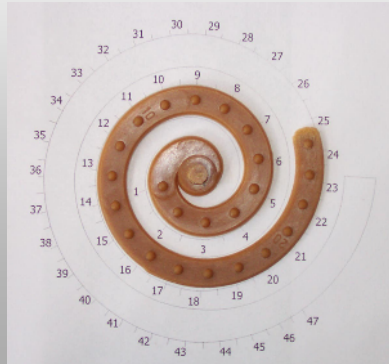
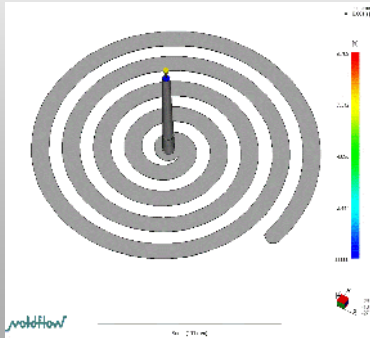
Validation of transfer
operations from real to virtual



Transfer from real to virtual world



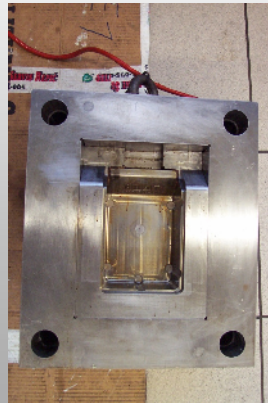
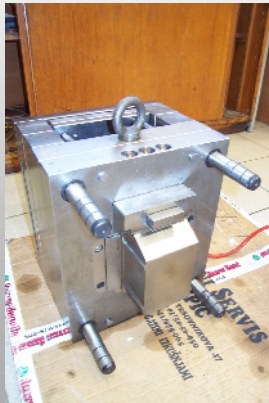
3D-computer aided process simulation



4. INJECTION MOULDING OF INDUSTRIAL PRODUCTS

Appropriate moulds in industry 2819 used for pre-testing

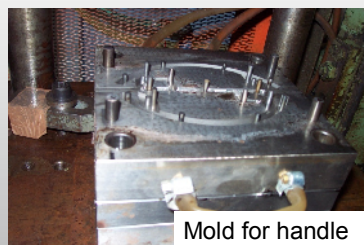
Mould for screw boxes



Screw box made from PP-wood composite

Appropriate moulds in industry 2819 used for pre-testing

Coffie handle



Mold for handle

Dimension Shrinkage:

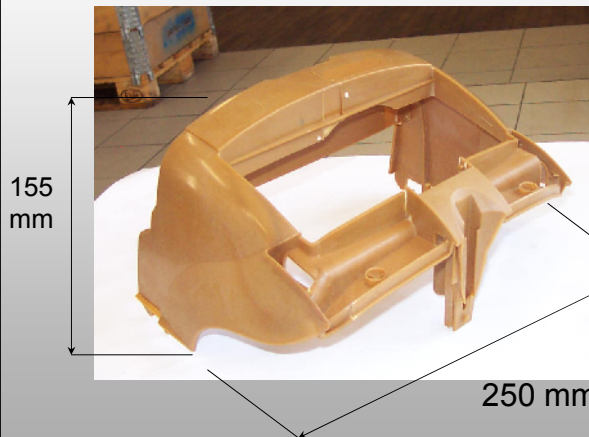
| | | |
|-------|---------|------|
| part: | Wood/PP | 0.5% |
| | PP 100% | 1.6% |



Coffie handle

Injection molding of vacuum cleaner hub

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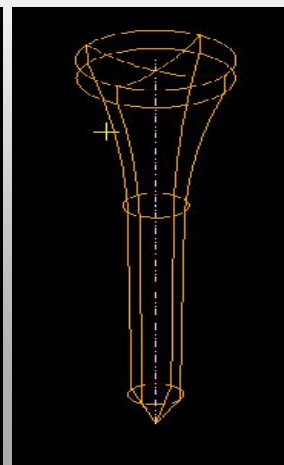
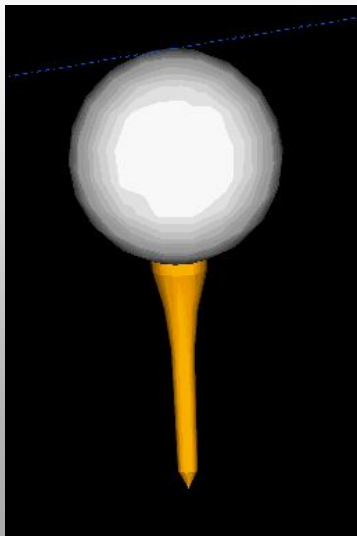
Relatively complex part, large thin walls, large surfaces, complicated details.

Shrinkage is different, has an anisotropic character

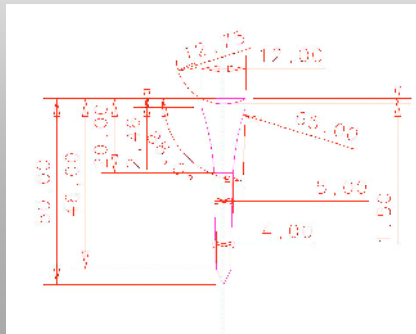
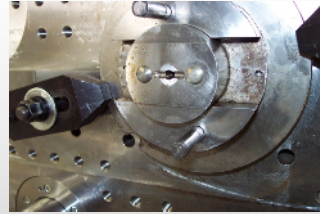
E! Eco-friendly “golf tie”?

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thousands are lost, natural disintegration possible



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Golf tie

Σ! 2819
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- Wood-plastics composites are definitely materials of the future.
- Mechanical properties are increased almost linearly with addition of natural fibres.
- Choosing the right coupling agent is of the most importance, since it can improve performance up to 30 - 40 % in comparison to poorly chosen one.
- Also one important quality is gained: the touch and warmth of wood, which is especially important for floor decking, laminates, garden furniture etc.