In vitro characterization of a new composite material for biomedical applications and 3D (bio)printing

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Study goal

The present project aims at evaluating the cytocompatibility and printability of a new composite material, based on a mixture of a new methacrylate-based monomer developed within a CTI project (18514.1 PFLS-LS) and glass-ceramic powder supplemented with co- and photo-initiators (patent in preparation).
This study is the basis to demonstrate the suitability of the biomaterial, for biomedical applications, such as stent, orthopedic implants and hearing aid components, as well as for 3D (bio)printing

Key findings

- **Cultivation, proliferation and differentiation of three different human cell types were successfully established on composite material discs (1cm diameter, 1mm height). Biological activity was shown**
- **The material is suitable for 3D (bio)printing, printing protocols were established**
- **The new composite material is suitable for cell and tissue interaction in biomedical applications**

Project data

Cells adhesion and proliferation

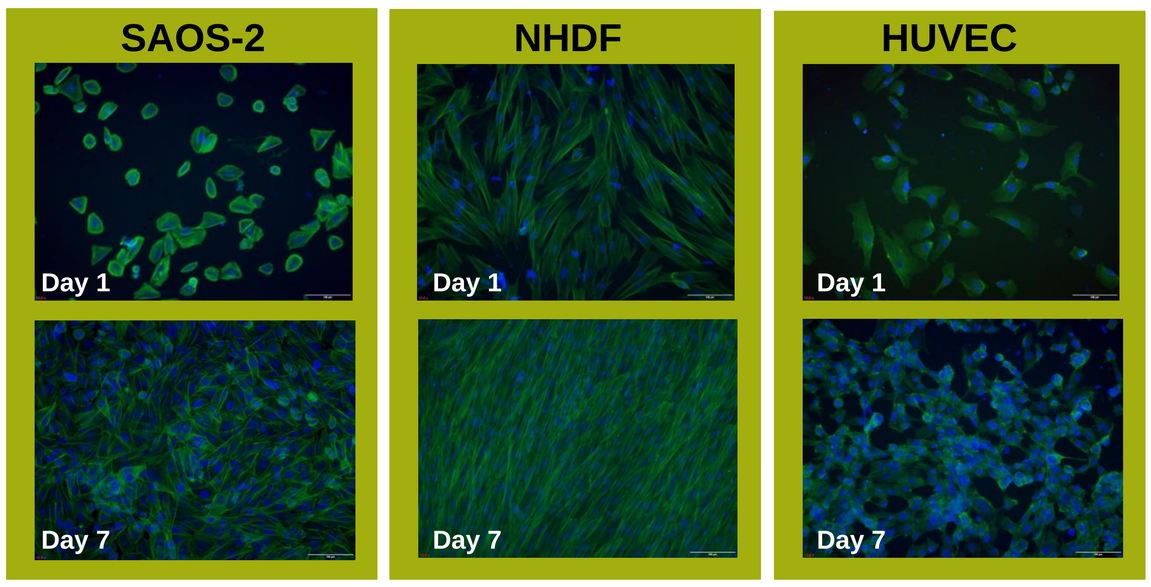


***Figure 1**: SAOS-2 (osteoblasts), NHDF (fibroblasts) and HUVEC (endothelial cells) seeded onto discs and cultivated up to 7 days before staining for F-actin (green signal, fluorescent phallacidin) and nuclei (blue signal, DAPI). Scale bar, 100µm*

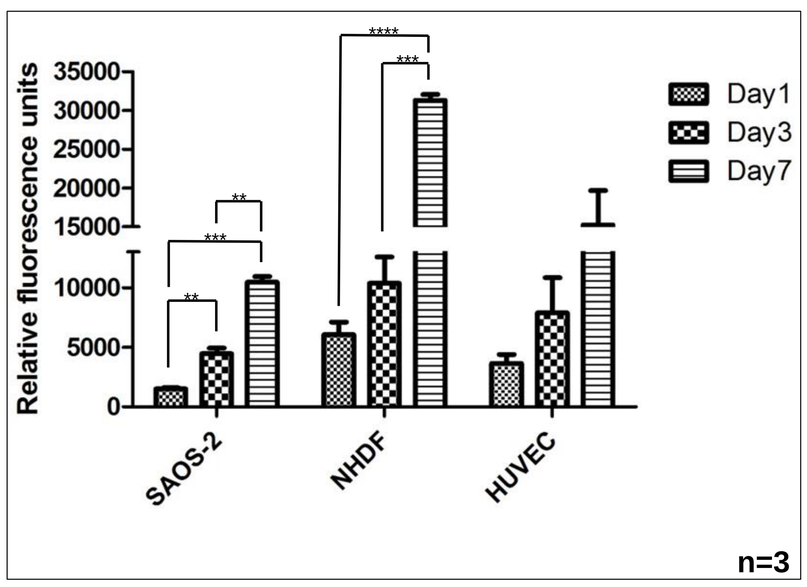
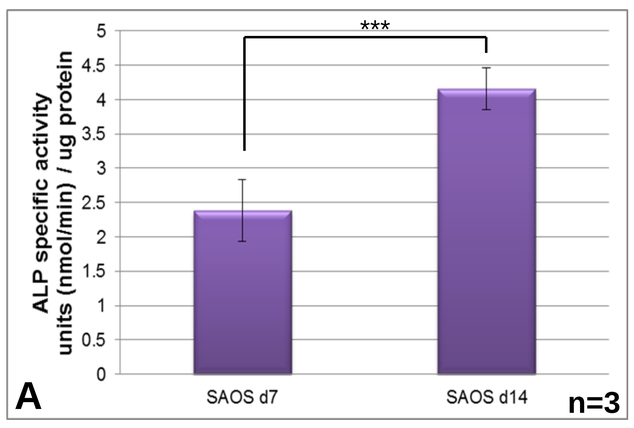
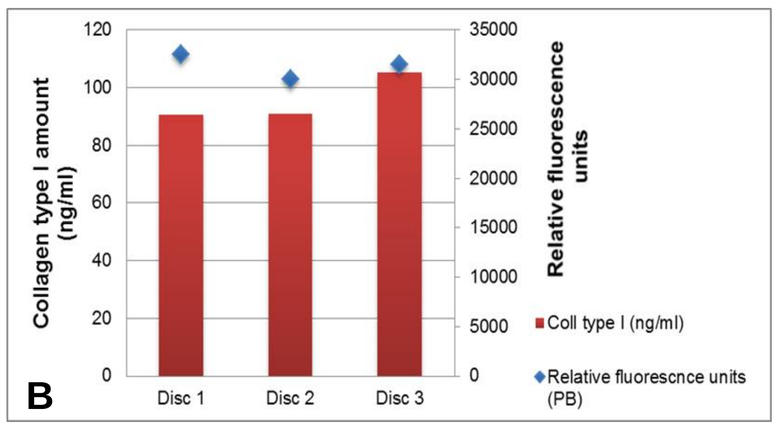


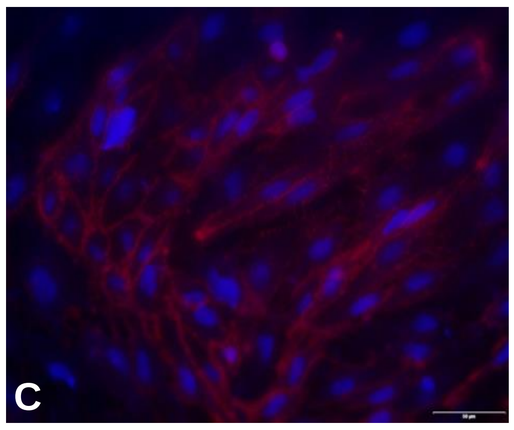
***Figure 2**: Metabolic cell activity detected with PrestoBlue at day1, 3 and 7. Unpaired T-test, p-values: ** p<0.01; *** p<0.001; **** p<0.0001*

- ✓ All cell types adhere, spread and proliferate on the biomaterial over time
- ✓ Cells are able to form a monolayer at day 7 on top of each discs

Biological cell activity





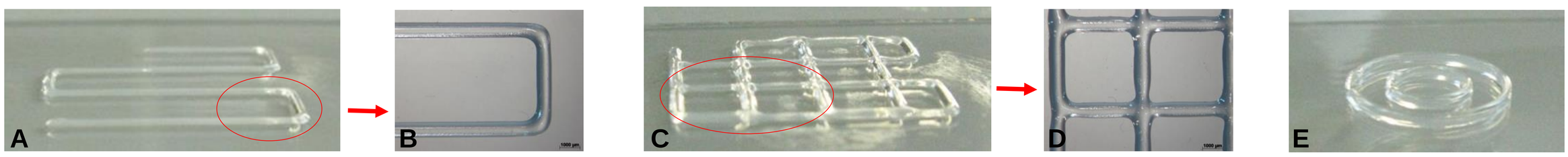


SAOS-2 **NHDF** **HUVEC**

***Figure 3**:*
***A**, ALP activity normalized to total protein amount on SAOS-2 culture. Unpaired T-test, *** p<0.001*
***B**, Coll I expression in fibroblasts cultures vs metabolic activity*
***C**, CD31 immunocytochemistry analysis in HUVEC cells cultivated up to 7 days (red signal). Nuclei in blue (DAPI). Scale bar, 50µm*

- ✓ SAOS-2 express ALP osteogenic marker
- ✓ Fibroblasts express and secret collagen type I
- ✓ HUVEC express CD31 with a tendency for cell alignment at day 7

Biomaterial printability



- ✓ The composite biomaterial is printable in a precise manner
- ✓ Well defined structures/models with high resolution can be obtained
- ✓ 3D printed models tested are stable showing rigid shape

***Figure 4**: 3D structures printed with 3DDiscovery (regenHU) with direct dispensing in a layer-by-layer fashion. **A**-**D**, 3 layers models; **E**, 10 layers model. Scale bar, 1000µm*

Conclusions

The new composite material is not only cytocompatible (DIN EN Iso 10993-5), but also allows the biological activity of human cells (spreading, proliferation and differentiation). Moreover, preliminary studies demonstrate the suitability of the material for (bio)printing. The composite shows high potential as biomaterial for 3D printing in different biomedical applications

Acknowledgments

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