



HAL
open science

An innovative sol-gel based hybrid biomaterial for bone tissue engineering

Henri Granel, C. Bossard, Fabien Wauquier, Anne-Marie Collignon, G.Y. Rochefort, Edouard Jallot, J Lao, Y. Wittrant

► To cite this version:

Henri Granel, C. Bossard, Fabien Wauquier, Anne-Marie Collignon, G.Y. Rochefort, et al.. An innovative sol-gel based hybrid biomaterial for bone tissue engineering. Les 20. JFBTM journées Françaises de Biologie des Tissus Minéralisés, Mar 2018, Monaco, France. 2018. hal-01743984

HAL Id: hal-01743984

<https://hal.science/hal-01743984v1>

Submitted on 26 Mar 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

H. Granel¹, C. Bossard², F. Wauquier¹, AM. Collignon³, GY. Rochefort³, E. Jallot², J. Lao², Y. Wittrant^{1*}

1: INRA / UCA UMR 1019, 63122 THEIX, France; *yohann.wittrant@inra.fr

2: UCA / CNRS-IN2P3, UMR 6533, 63170 AUBIERE, France

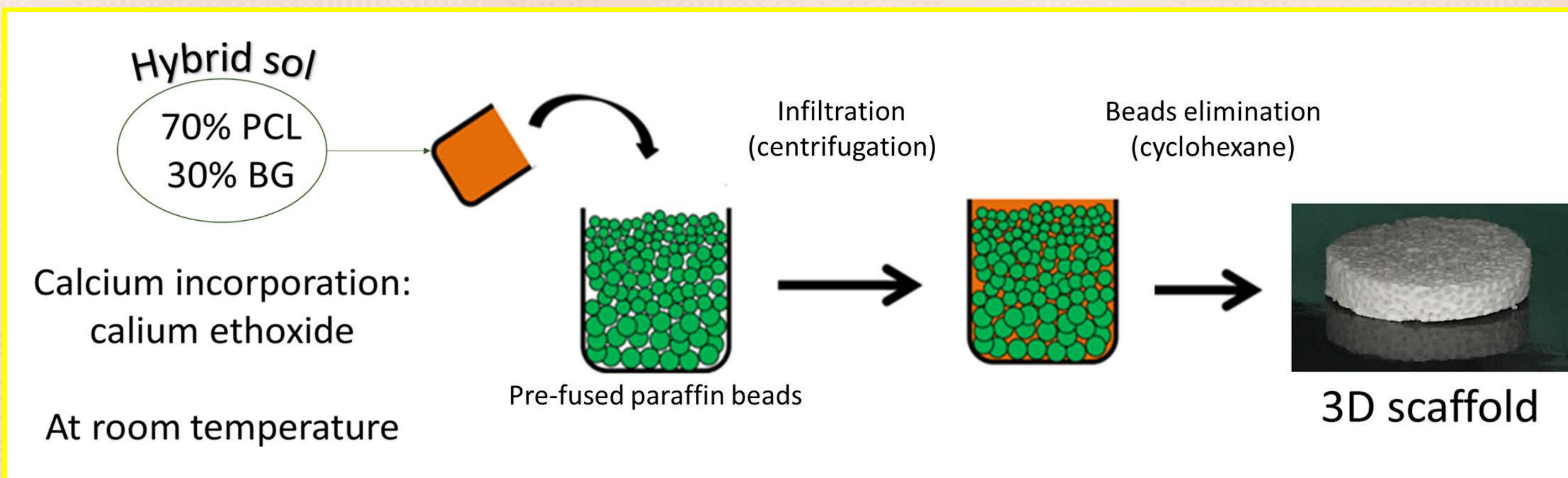
3: Faculté de chirurgie dentaire, EA2496, 92120 Montrouge, France

Introduction:

Among the materials used as bone substitutes, **bioactive glass** (SiO₂ CaO) (BG) has a **high potential**. BG is **biocompatible** and is able to strongly **bind to bone**. It is **bioresorbable** and its dissolution products **stimulate bone regeneration**. However, BG is **not suitable for scaffolds** as it is brittle and its applications are limited to bone fillers. From a chemical point of view, natural bone is a hybrid consisting of a mineral and an organic phase intimately linked at the molecular level. **Thus, combining BG with a polymer** may address BG issues regarding **elasticity** while **preserving its biological properties**. We recently **patented a sol-gel organic-inorganic hybrid porous scaffold** consisting in **BG** and a synthetic polyester, **polycaprolactone (PCL)**. The aim of this study was **to determine and improve the mechanical and biological properties** of this **original biomaterial**. RPO: rat primary osteoblasts; BG-PCL: bioactive glass with PCL; BTB: bovine trabecular bone

Synthesis, characteristics and mechanical properties of BG-PCL scaffolds

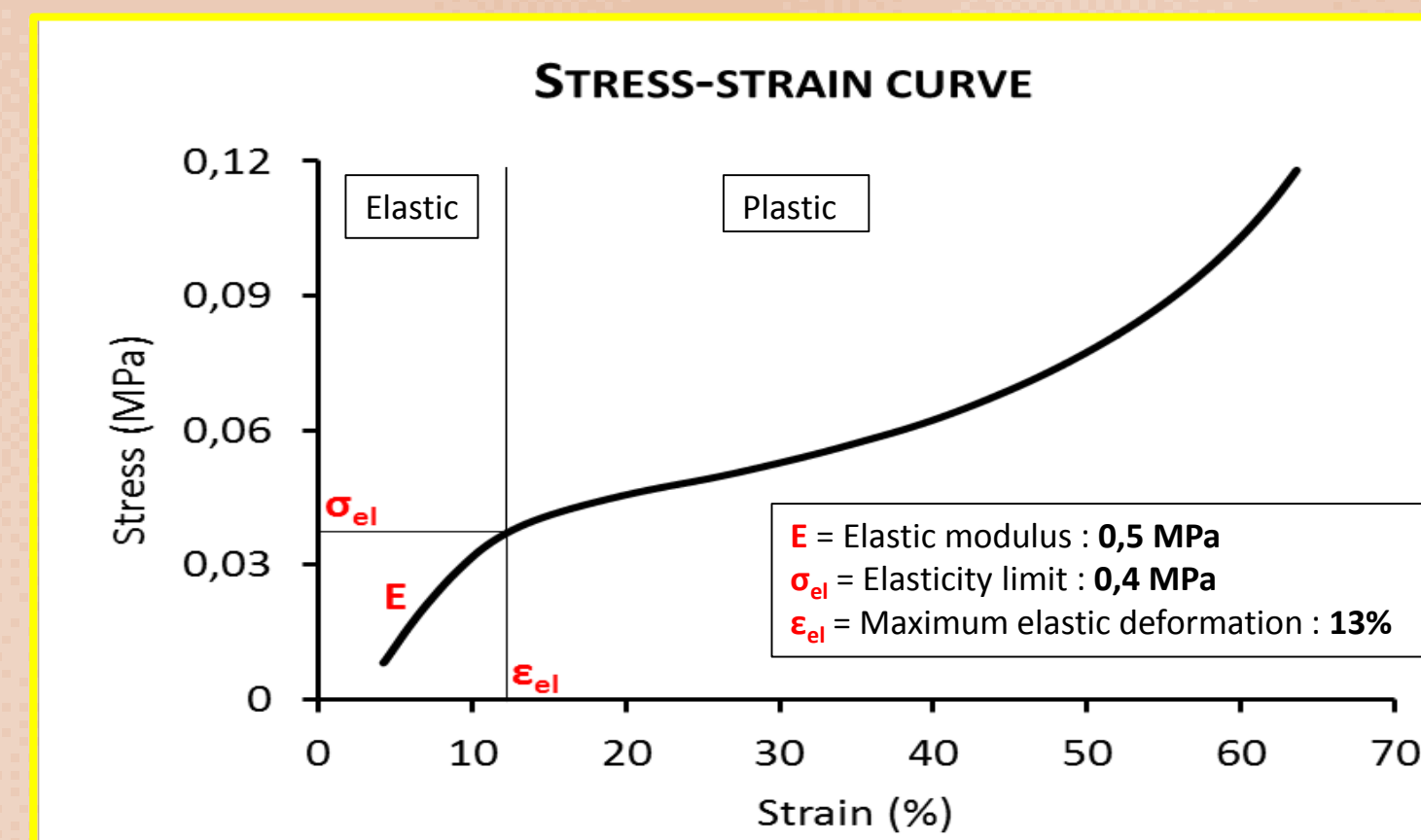
Room temperature synthesis route



Room temperature
Uniform distribution of calcium

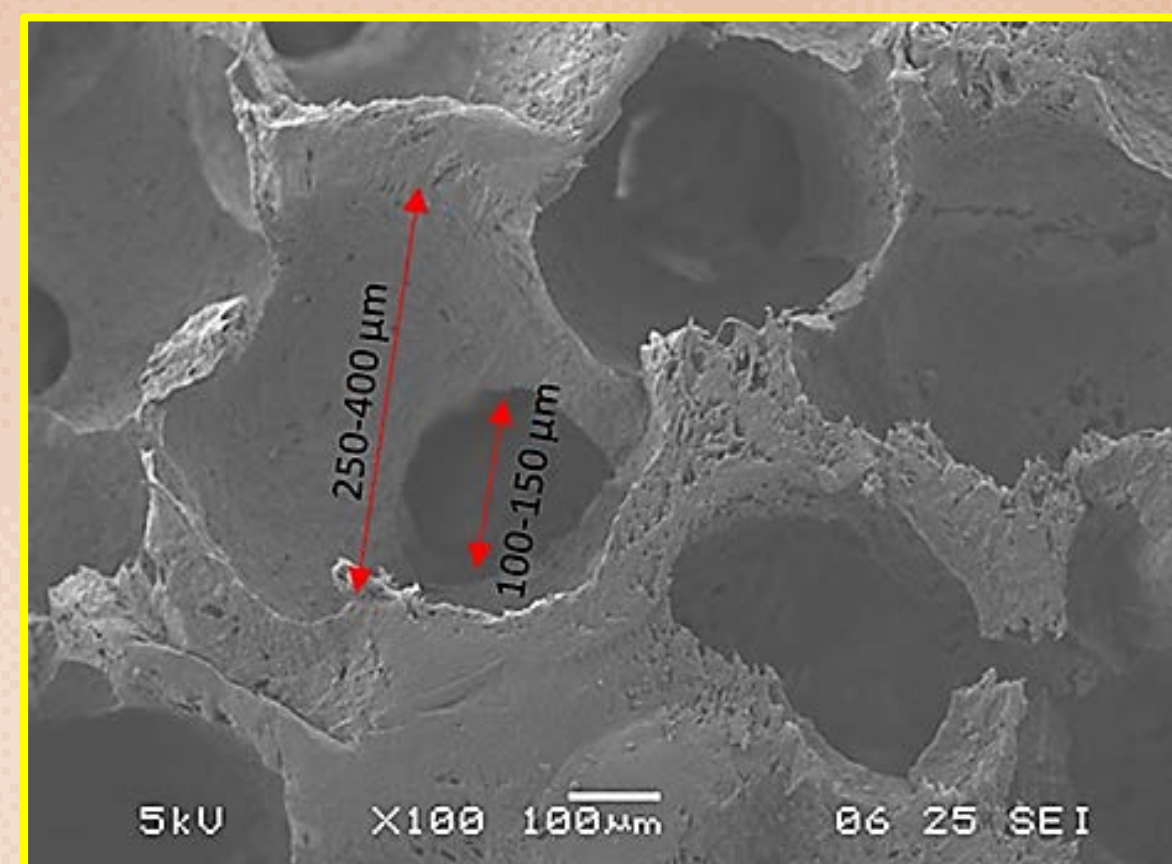
Compatible with polymers
No residual methanol

Elastic-plastic material



None brittle and deformable
Interconnected porosity suitable for cell colonisation

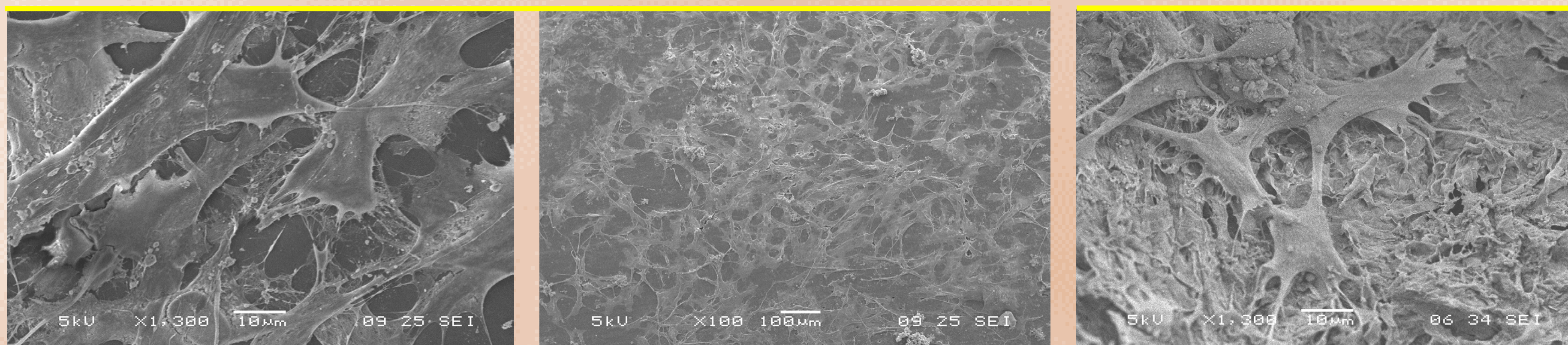
Interconnected porosity



Biological properties of BG-PCL scaffolds

Promotion of cell attachment – Electron scanning microscopy

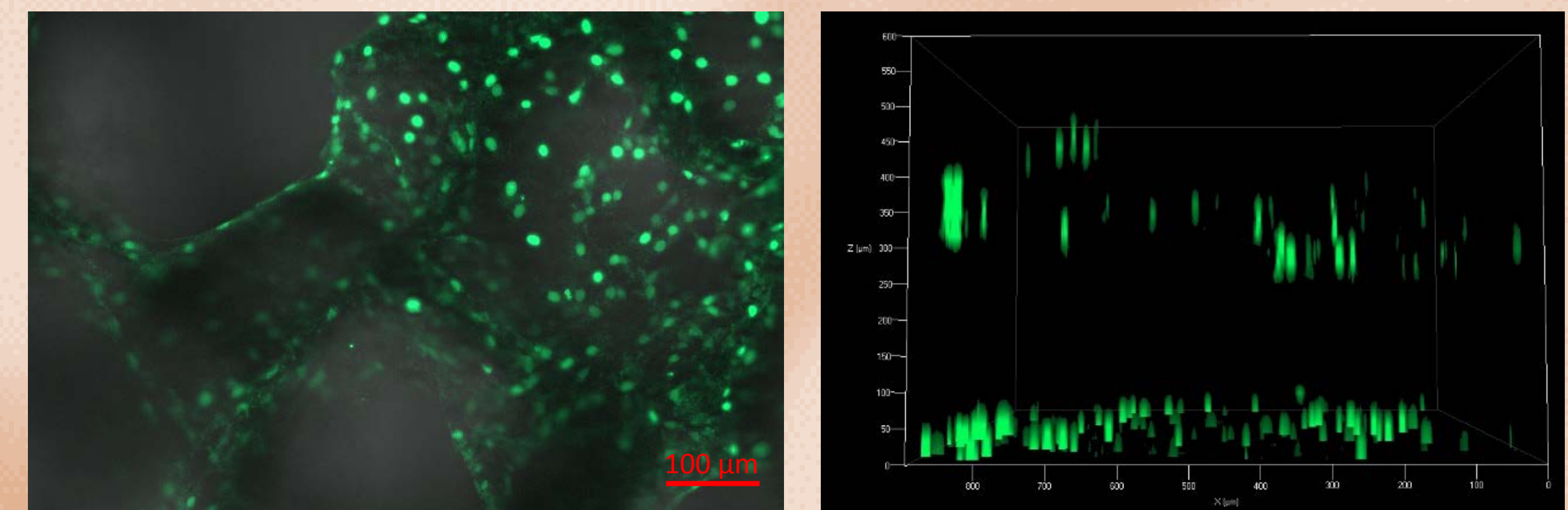
Rat primary osteoblasts (RPO) on a BG-PCL pellet



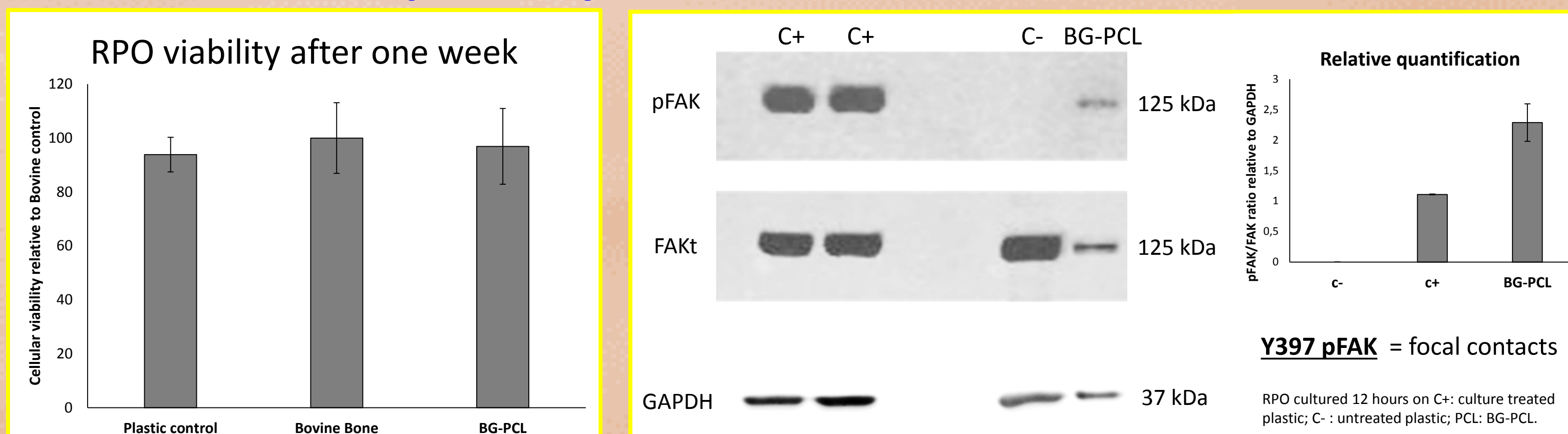
3D cell distribution – Apotome fluorescent microscopy

RPO on a BG-PCL scaffold

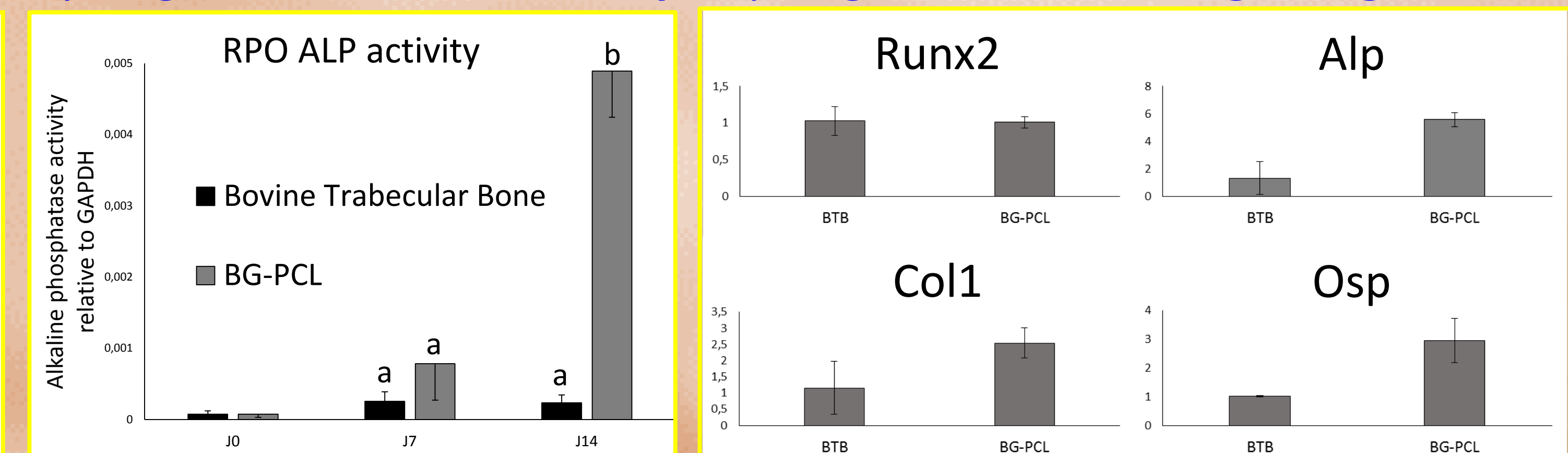
RPO distribution inside scaffolds



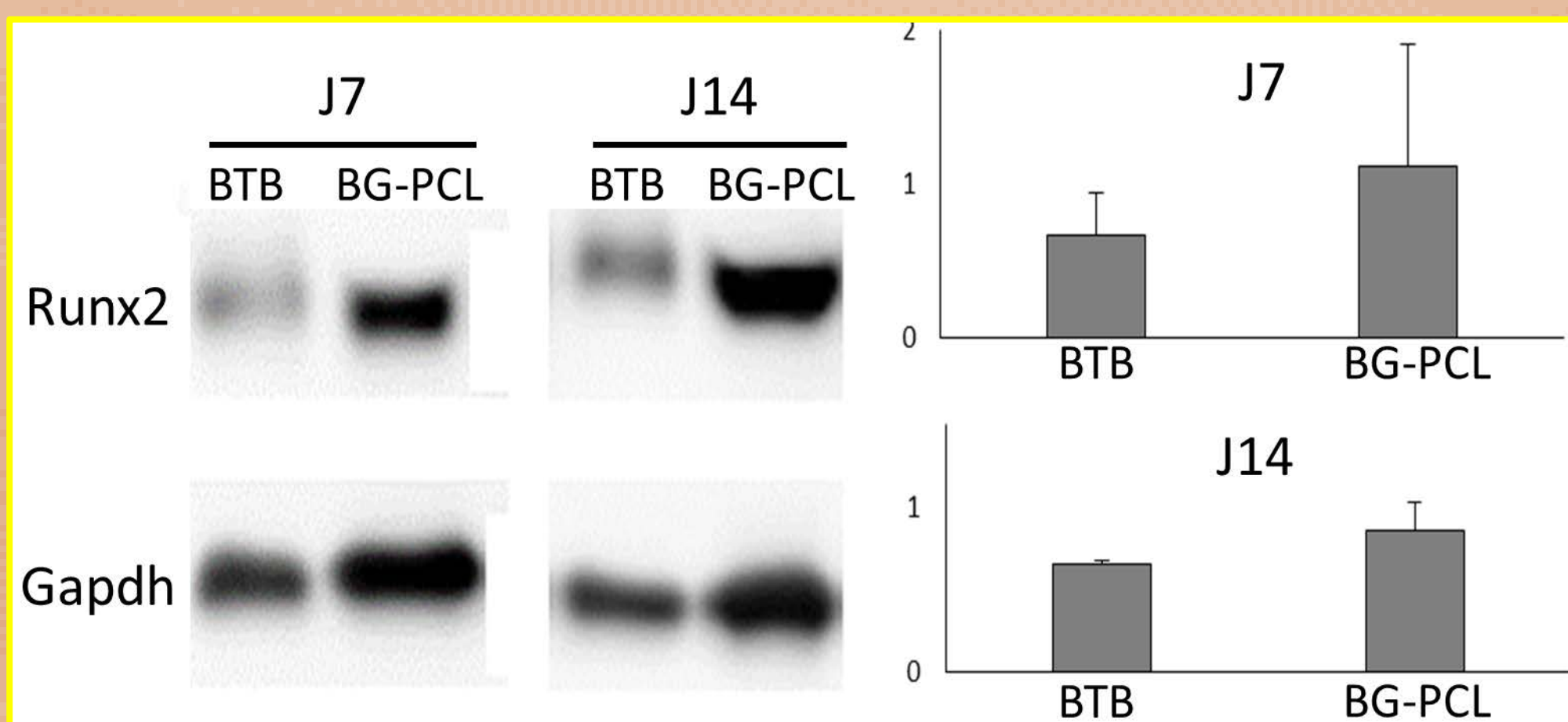
Preserved biocompatibility Stimulation of focal contacts



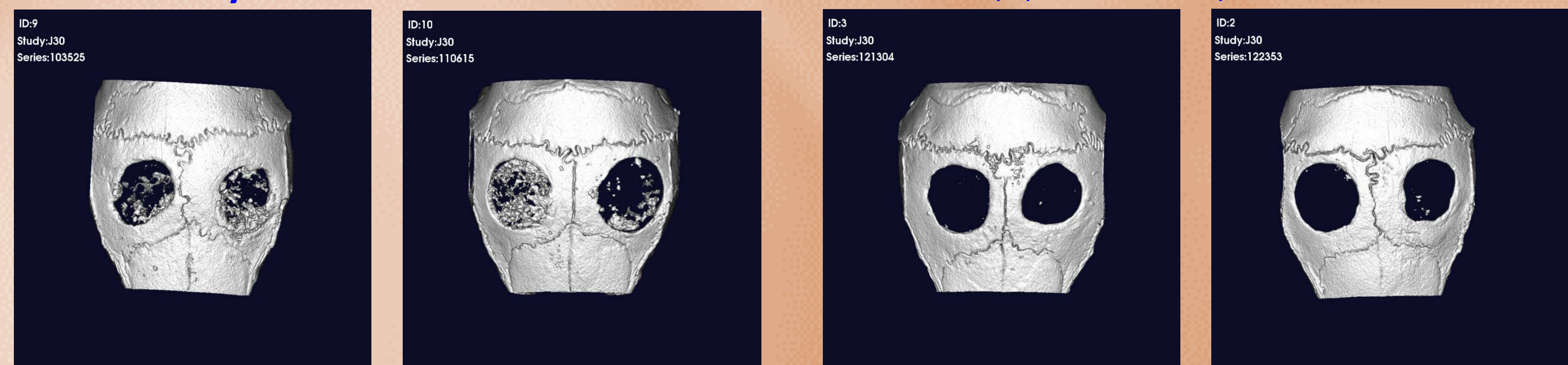
Up-regulation of ALP activity Up-regulation of osteogenic genes



Enhancement of Runx2 in RPO



Validation by in-vivo models - Mineral structures observed at 30 days post- craniotomy in mice



Conclusion:

BG-PCL hybrid scaffolds may represent a **ground-breaking** step in **bone regenerative medicine**. They preserve osteoinductive properties while addressing brittleness of bioactive glasses. Their **synthesis route** at room temperature offers **new opportunities for organic doping and improved bone regeneration**

Acknowledgments: Région Auvergne-Rhône-Alpes, Fonds Européens de développement régional (FEDER), Lotfi Slimani, Plateforme de Micro-CT EA2496 Montrouge, Brigitte Gaillard-Martinie, Plateau Technique de Microscopie Centre INRA ARA (UMR 454 MEDIS)