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

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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

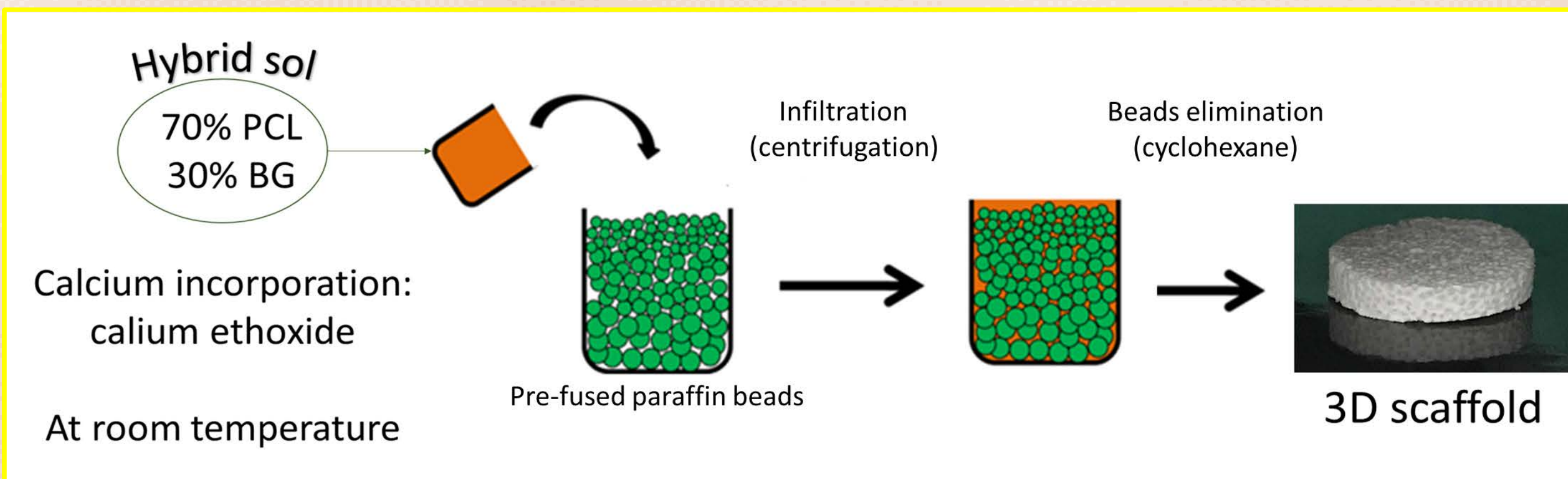
3: Faculté de chirurgie dentaire, EA2496, 92120 Montrouge, France

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

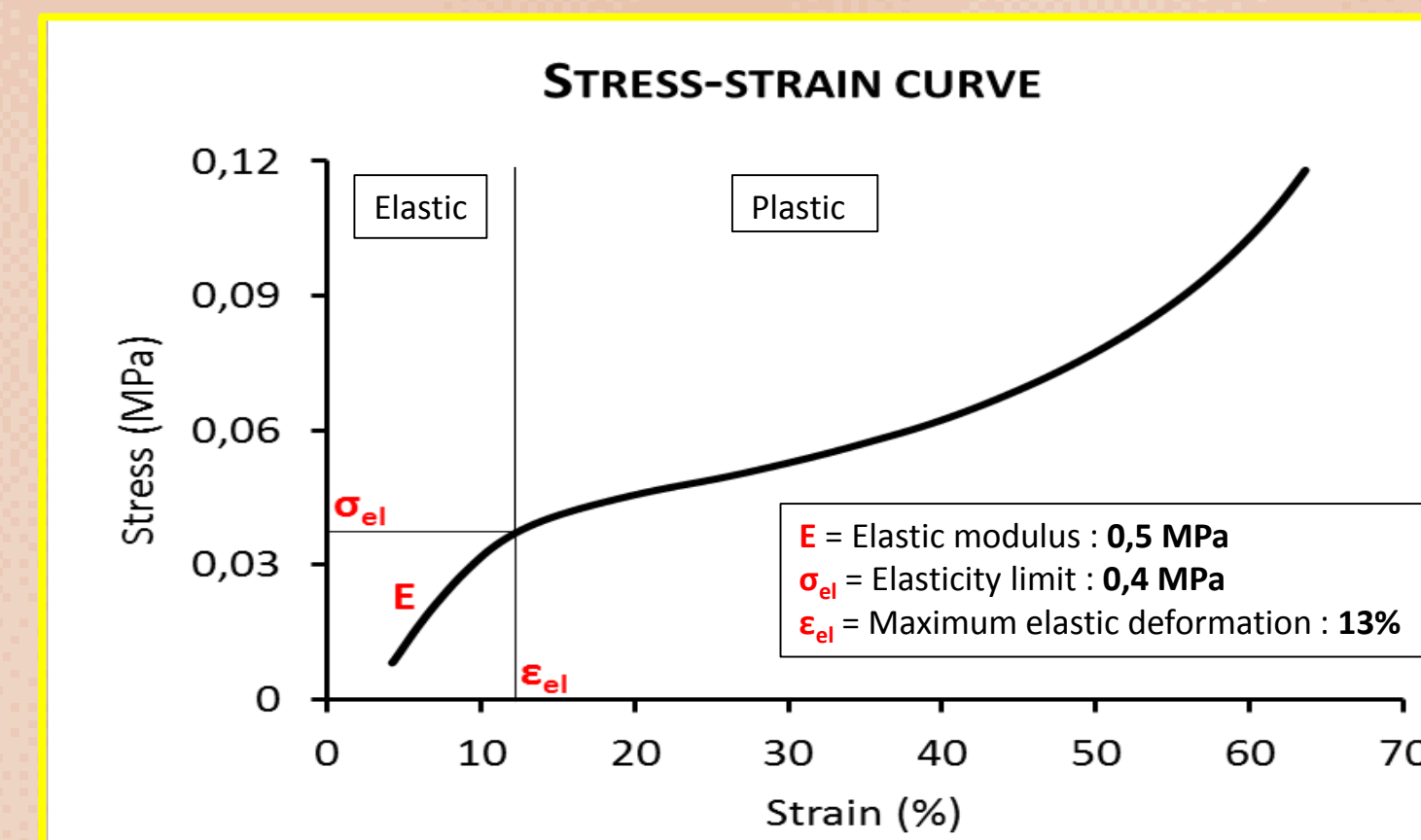
Room temperature synthesis route



Room temperature
Uniform distribution of calcium

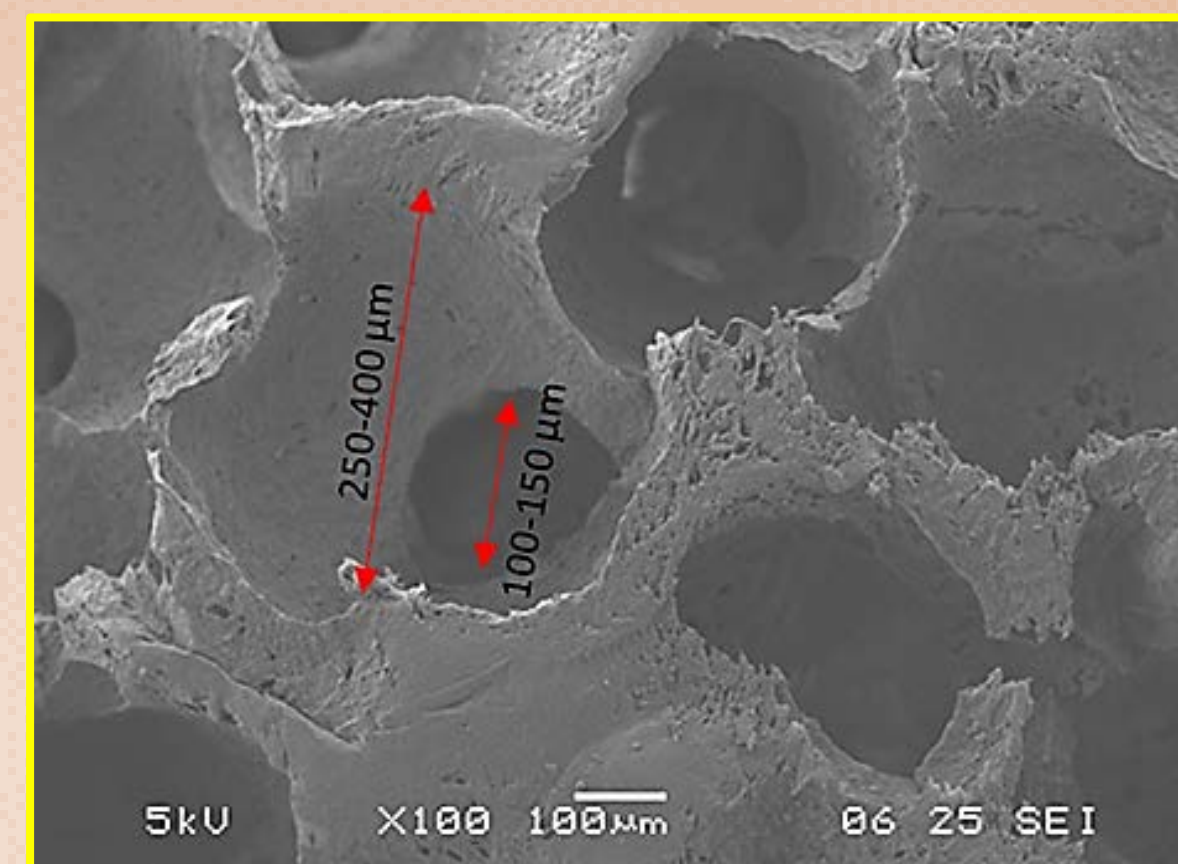
Compatible with polymers
No residual methanol

Elastic-plastic material



None brittle and deformable
Interconnected porosity suitable for cell colonisation

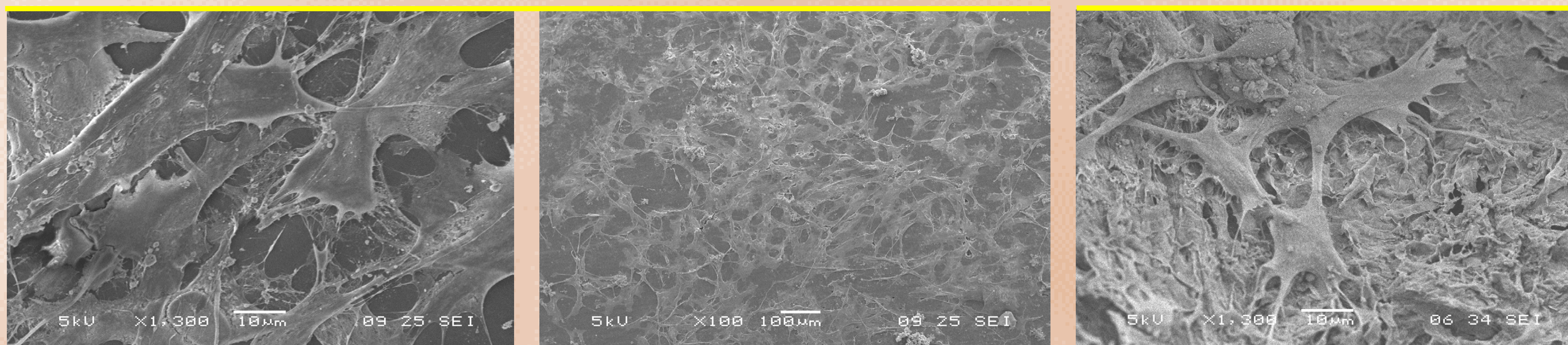
Interconnected porosity



Biological properties of BG-PCL scaffolds

Promotion of cell attachment – Electron scanning microscopy

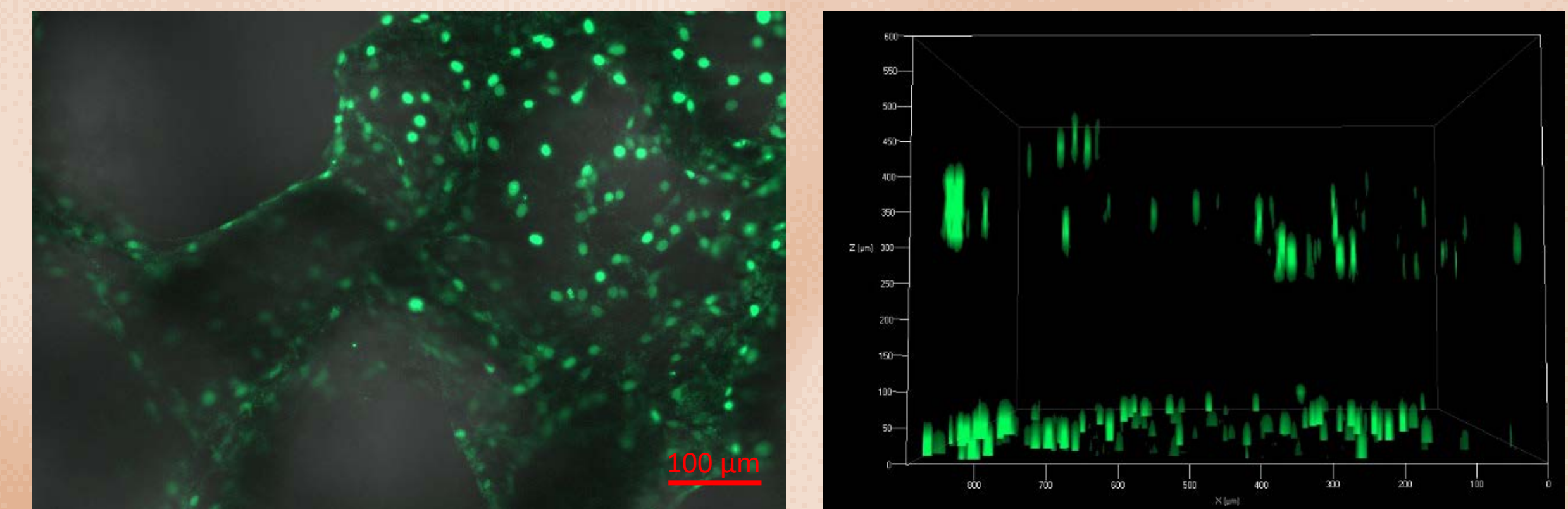
Rat primary osteoblasts (RPO) on a BG-PCL pellet



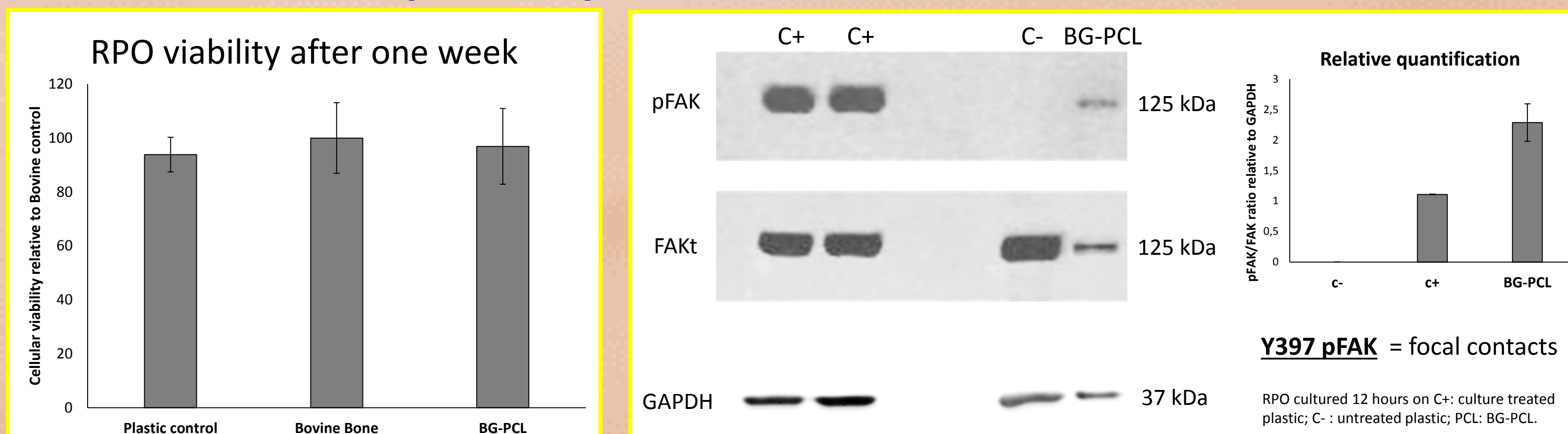
3D cell distribution – Apotome fluorescent microscopy

RPO on a BG-PCL scaffold

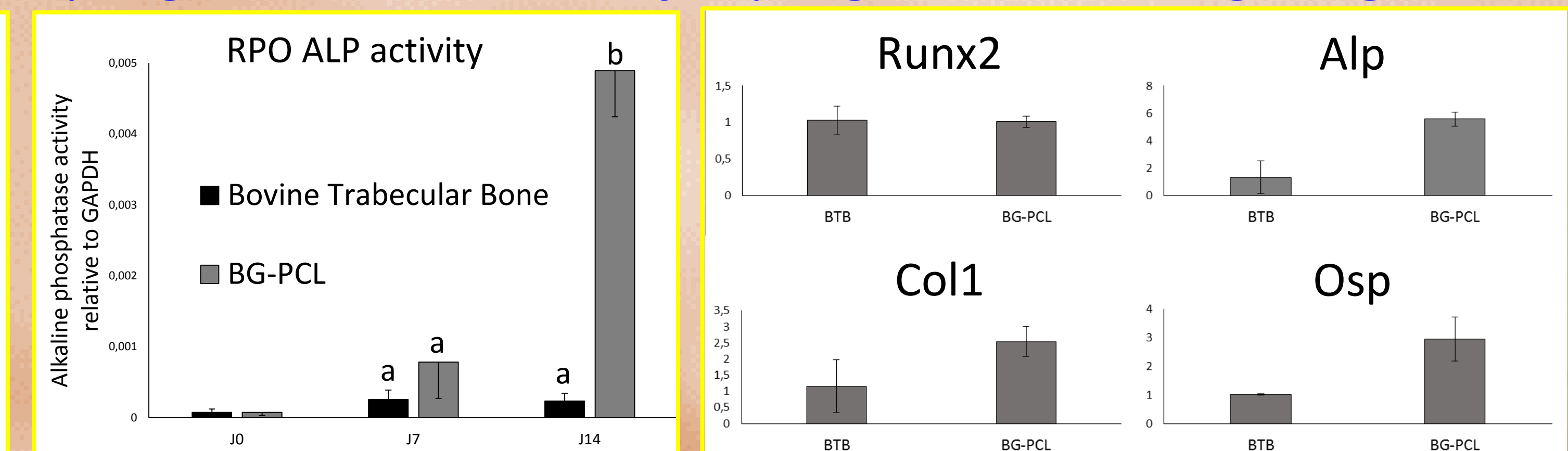
RPO distribution inside scaffolds



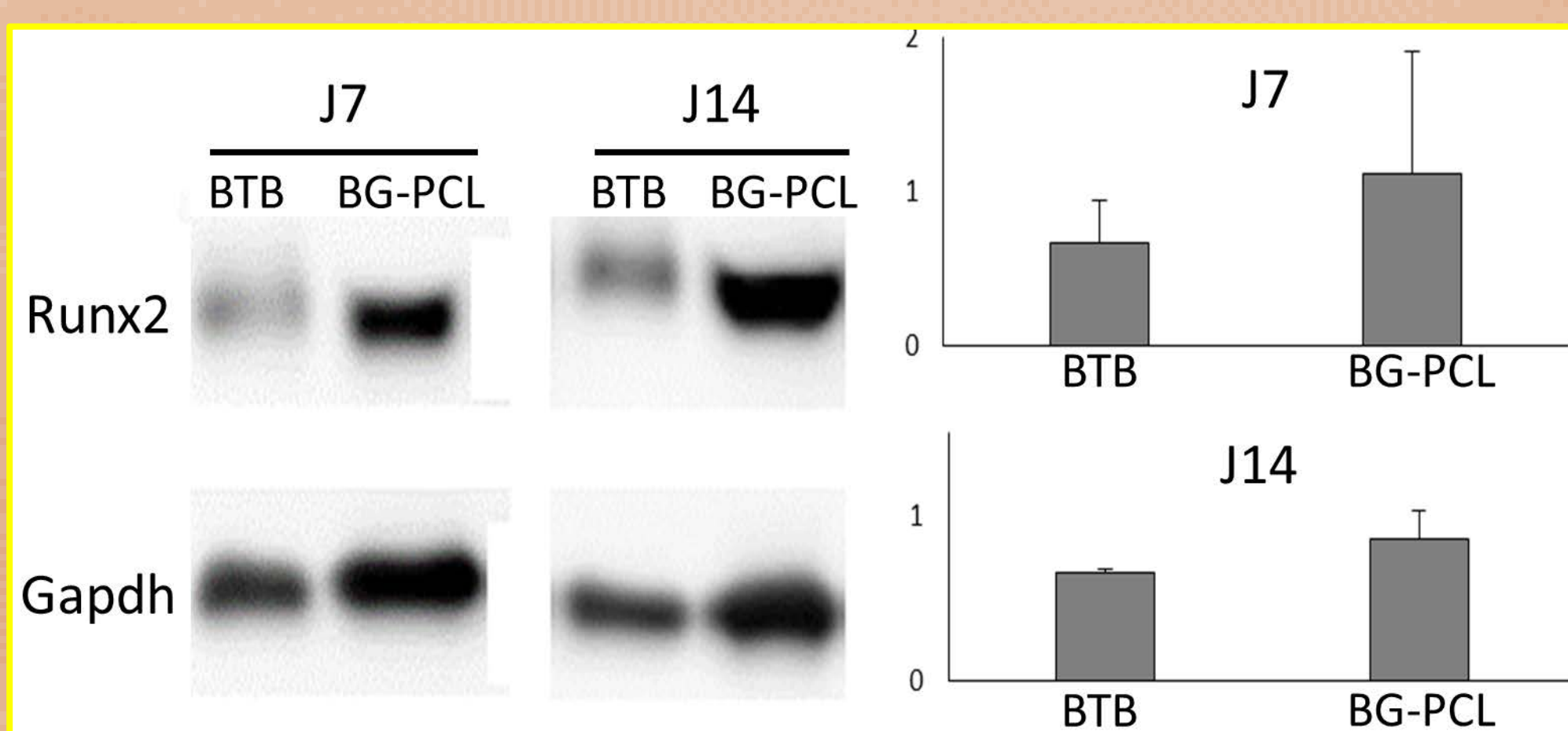
Preserved biocompatibility Stimulation of focal contacts



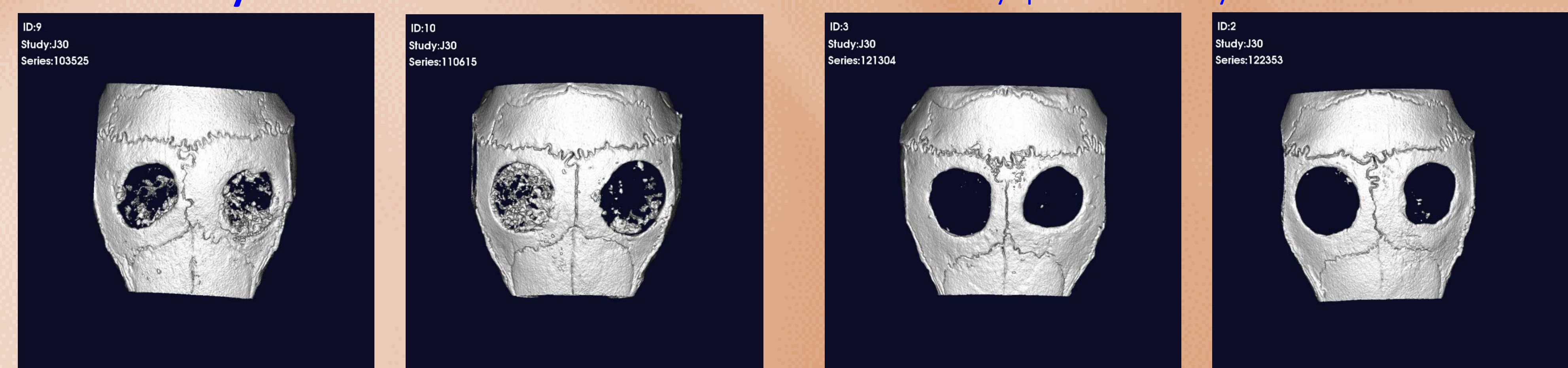
Up-regulation of ALP activity Up-regulation of osteogenic genes



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**

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