

Synthesis of collagen/hydroxyapatite composite materials with oriented microstructure induced by the interaction of the flowing mineralised collagen gel with the support

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Abstract : This paper presents the synthesis of collagen (COLL)/hydroxyapatite (HA) composite materials with oriented microstructure. The special microstructure of the composite materials is induced by the interaction of the flowing mineralised collagen gel with the support. The special morphology of the samples was pointed out based on the SEM images. It is worth to mention that the orientation is maintained even if two layers of COLL/HA is obtained. Most

important is that, function of the geometry of the support, irregular bone grafts with oriented morphology can be obtained. This is important because the other known methods do not allow the synthesis of irregular grafts. Also, this method can be well adapted to the synthesis of long bones. © Global Scientific Inc.

Keywords : Oriented microstructure; Collagen; Hydroxyapatite; Microscopy.

INTRODUCTION

The design of polymer composite materials relies on investigations into the chemistry, physics, biology and mechanics^[1]. Development of new materials and/or improvement of existent ones^[2,3], is largely caused by increased use of common and novel technologies^[4,5].

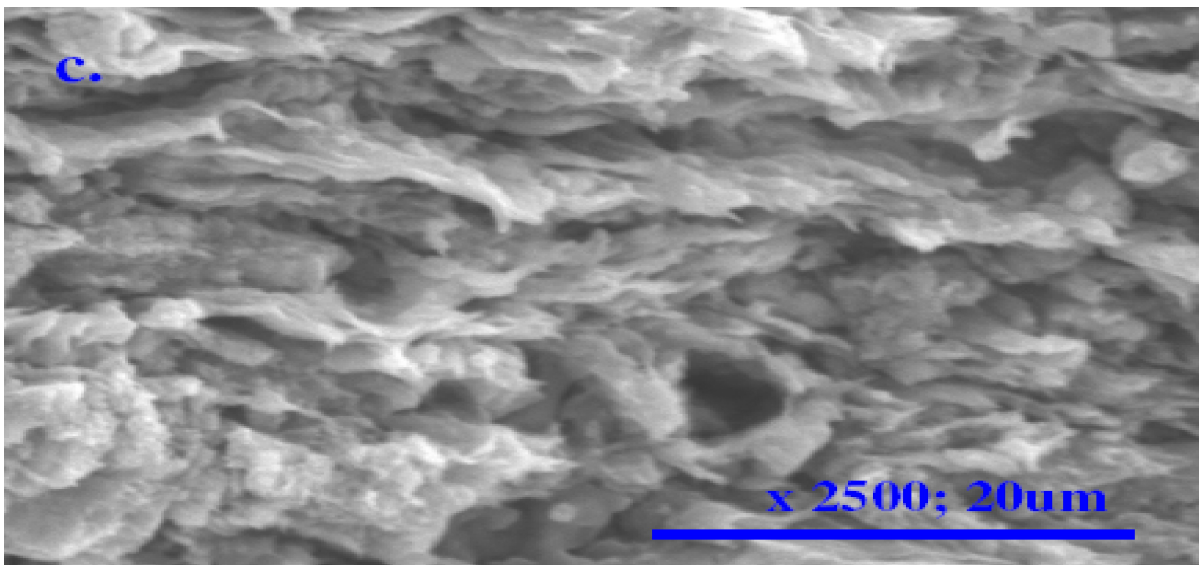
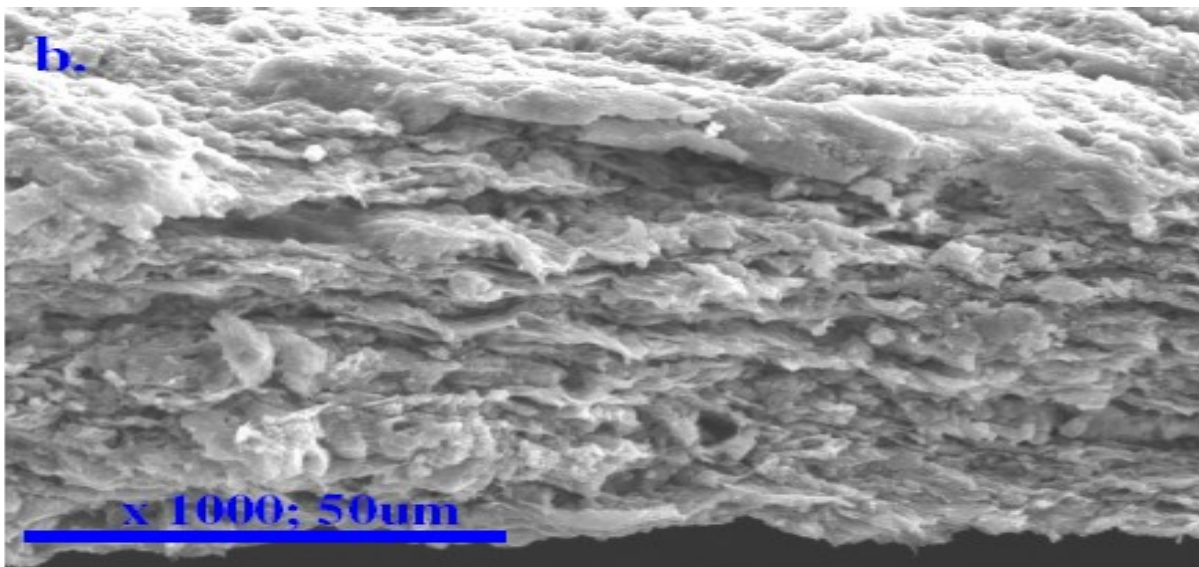
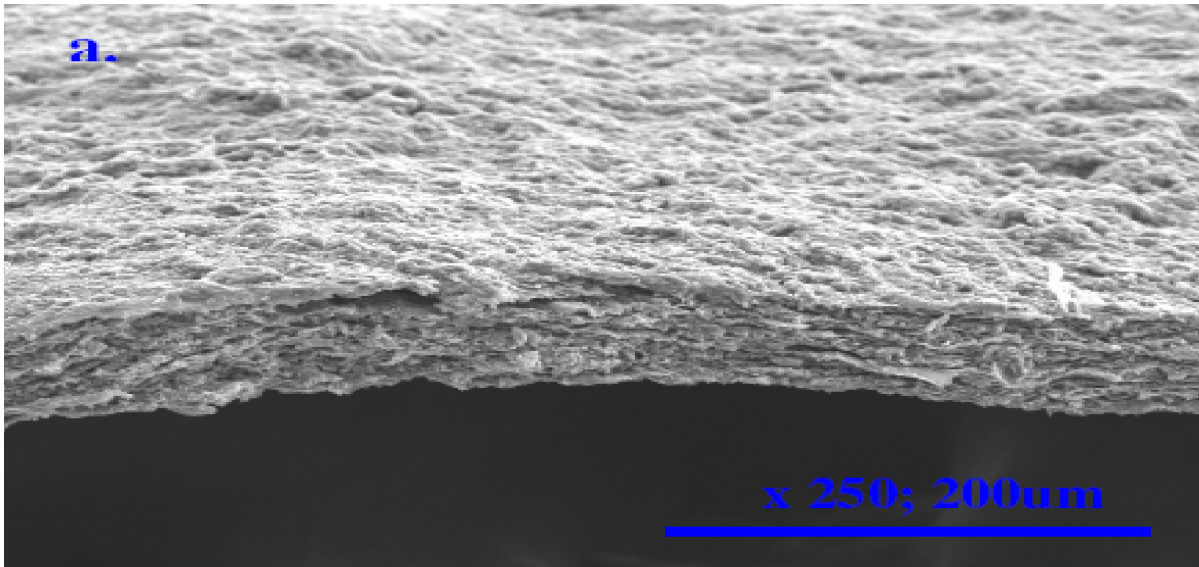
The synthesis of bone grafts with oriented microstructure is a challenge of the new century. Bone is an amazing composite material based especially on collagen and hydroxyapatite, as main components. Even if the compositional similarity was well achieved, the mor-

phological similarity is very poor and consequently the synthesis of high performance bone graft far to the expectations, especial from the point of view of mechanical properties^[6-11].

Till now, only a few works focused on the orientation of the microstructure were published. The first work in the field of unidirectional orientation was published by Wu and co-workers^[12]. This oriented microstructure was achieved due to the applied magnetic field (10T). Three years later, in our group, two new methods of orientation were proposed: self-assembling^[13] and electric field orientation^[14].

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1 Layer



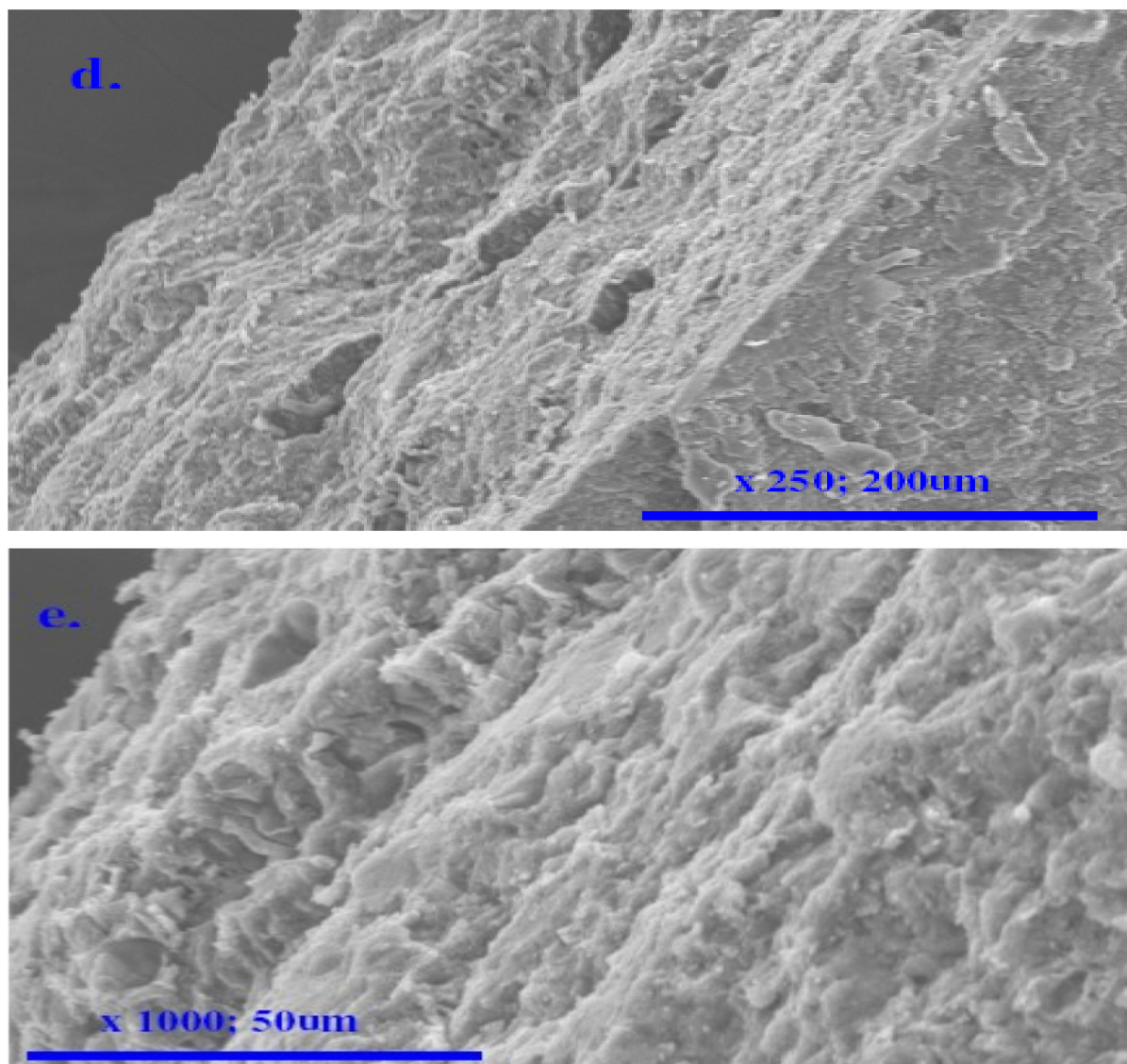
2 Layers

Figure 1 : Scanning electron images of COLL/HA composite materials

EXPERIMENTAL

Collagen (300.000 Da) gel 2.54% gel was obtained in the Leather and Footwear Research Institute – Collagen Department^[15,16] while the HA precursors ($\text{Ca}(\text{OH})_2$ and $\text{NaH}_2\text{PO}_4 \cdot x\text{H}_2\text{O}$) were purchased from Aldrich.

The synthesis of mineralised collagen gel was obtained as presented previously^[17]. The last step of the synthesis of COLL/HA composite materials with oriented microstructure consists in the dribbling of the mineralised collagen gel on a polypropylene tube. When two layered material with oriented microstruc-

ture is desired, the second dribbling of the mineralised collagen gel is realised onto the previous layer of COLL/HA material. The cross-linking of these materials is realized by spraying 1% glutaraldehyde onto the materials. When the two layered material is obtained additional cross-linking between layers is not necessary.

SEM analyses were performed on a HITACHI S2600N electron microscope on samples covered with silver layer.

RESULTS AND DISCUSSION

The morphology of the two obtained materials was

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analysed by SEM. It can observe that highly oriented and stratified morphology is obtained for both materials. The orientation of the fibres and plaquette is similar with the flowing direction. From the point of view of the degree of porosity it can conclude (based on The SEM analyses) that the obtained materials present low degree of porosity. In the case of the two layered composite material the second layer present lower degree of orientation comparing with the first layer obtained by dribbling directly on the polypropylene tube. This can be explained based on the preparation procedure. In the preparation of the first layer the flowing mineralised collagen gel interact directly with the polypropylene support while, in the case of the preparation of the second layer, the flowing mineralised collagen gel interacts with the first layer of COLL/HA.

CONCLUSIONS

A new method of synthesis of COLL/HA composite materials with oriented microstructure was presented. The oriented microstructure is obtained due to the interaction of the flowing mineralised collagen gel with the support. The second layer of COLL/HA have a lower orientation especially due to the fact that, the flowing mineralised gel used for the obtaining of the second layer is interacting with the first layer of COLL/HA and not with the polypropylene used as support for the preparation of the first layer.

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