ALD TiO$_2$-coated collagen: A novel biomaterial for bone grafting

Arghya Kamal Bishal$^1$, Cortino Sukoljo$^2$, Christos G Takoudis$^{1,3}$

$^1$Department of Bioengineering, University of Illinois at Chicago, Chicago, Illinois, 60607, USA, $^2$Department of Restorative Dentistry, University of Illinois at Chicago, Chicago, Illinois, 60612, USA, $^3$Department of Chemical Engineering, University of Illinois at Chicago, Chicago, Illinois, 60607, USA

Collagen is an important biomaterial which is used in several biomedical applications. It has a triple helix structure made of polypeptide chains. Hydrogen bonds play an important role in keeping together these peptide chains. Glycine, proline are the most abundant amino acids found in its structure. Collagen has also the ability to be reorganized and crosslinked and thus turn into flexible fibrils with higher tensile strength. There are four main types of collagen: type I, II, III and V. Among them mostly type I and little amount of type V construct the bone structure by forming a composite with hydroxyapatite (HA) crystals.

In medicine, the use of implants is growing rapidly. Some patients may not have enough bone to support such implants. Therefore, those patients are required to have augmentation, a procedure to increase the height or width of inserted bone-like supporting materials, prior to implantation. Collagen resorbable membrane is used as a bone grafting material which acts as supporting material and facilitates new bone formation. Sometimes, titanium reinforced collagen membrane is used for improved stability.

Titania (TiO$_2$) itself is biocompatible. Additionally, it has the ability to attract Calcium and Phosphate in a liquid environment. Therefore TiO$_2$ coated collagen may be used as an excellent bone grafting material to nucleate Ca and P and thus reconstructing a stable bone structure. In this work, we present ALD of TiO$_2$ on collagen membrane in a custom-made ALD reactor. The deposition was performed at room temperature. Tetrakis(dimethylamido)titanium (TDMAT) and ozone were used as metal precursor and oxidizer, respectively. Samples were characterized for their surface morphology, composition and mechanical properties. Energy dispersive spectroscopy confirmed the presence of Ti on coated collagen and electron microscopy showed an increase in fiber diameter after deposition by more than a factor of 2: