

## ABSTRACT

Silicon Nitride (SiN) is a stable ceramic material used in high performance industries such as turbocharger engines and NASA's Space Shuttle engines. With the hydrophilic and microtextured surface characteristics, SiN has been used as orthopedic spinal fusion devices as an alternative to Titanium (Ti) and polyether ether ketone (PEEK) implants. In vitro/vivo studies show its potential for use as a dental implant material.

## INTRODUCTION

Silicon Nitride (SiN) is a ceramic material currently being used in orthopedics for spinal reconstructive surgeries. Preliminary data shows that not only is this material able to osseointegrate with bone, but it also has bacteriostatic properties which could be beneficial in the oral cavity.

## PURPOSE

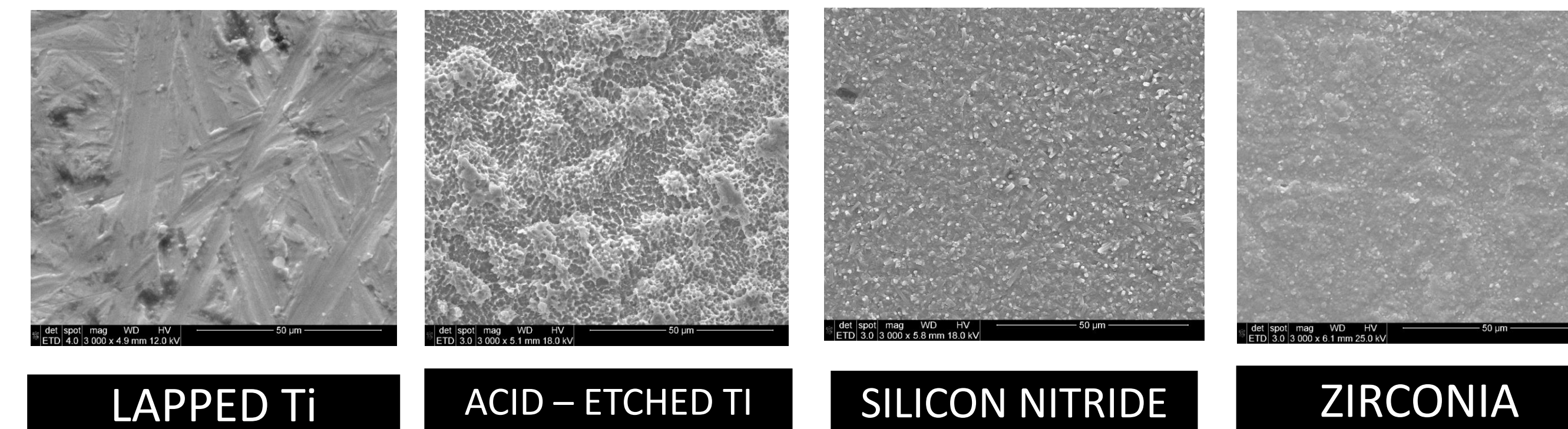
The biological behavior of SiN bioceramics was compared to titanium biomaterials in vitro with MSCs and human BMSCs, and in vivo using a mouse femur model.

## METHODOLOGY – In VITRO STUDY

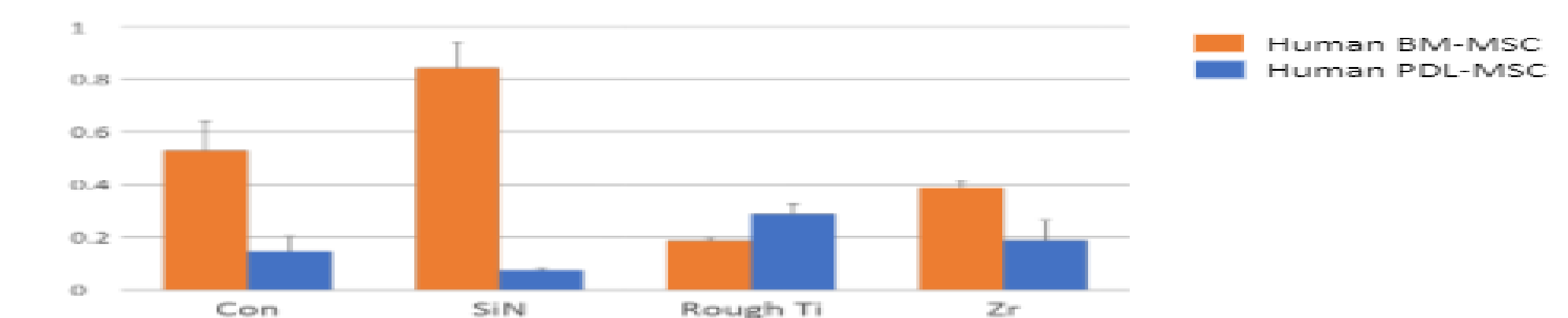
- Two groups (A & B) were established.
- Six materials (SiN, Smooth Ti, rough Ti, PEEK, Zirconia, Control) were compared and three samples of each were tested.
- Round discs of each were placed in petri dishes
- Group A discs were inoculated with periodontal ligament mesenchymal stem cells (Group A-PDLMSC) and Group B discs with bone marrow mesenchymal stem cells (Group B-BMMSC)
- A culture medium that simulated the oral environment was utilized and changed twice a week for 21 days
- Alizarin Red" staining was used to quantify the amount of calcium induction of the cells
- Tukey-Kramer multiple comparisons test was used to determine statistical significance for both groups

## SURFACE CHARACTERIZATION

Surface topography was analyzed for Ti, acid-etched Ti (AE-Ti), SiN and Zirconia discs. **SiN, Zirconia demonstrated similar topography, Whereas AE Ti was rougher.**

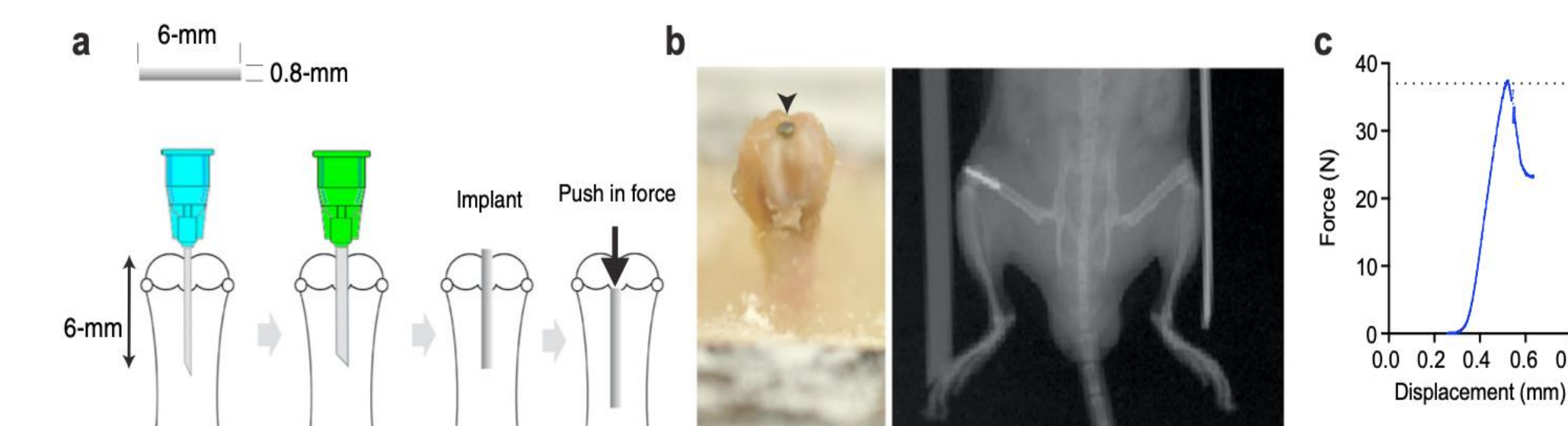


## In vitro mineralization nodule formation



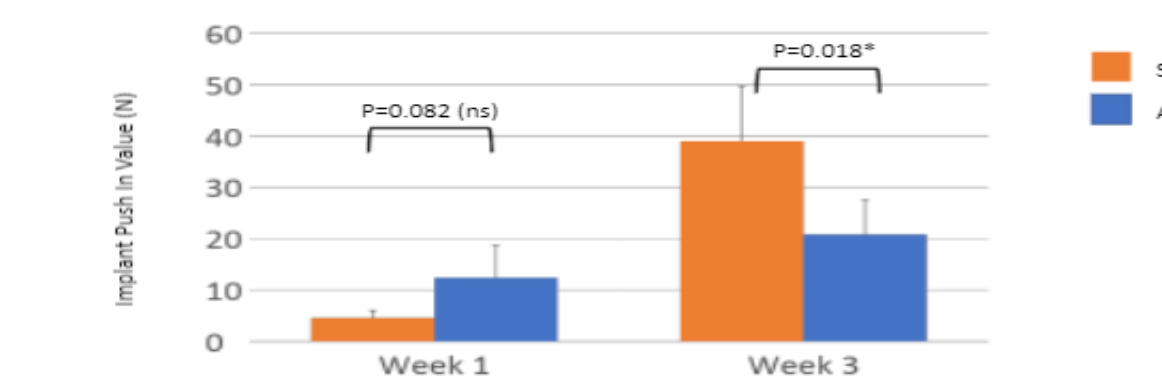
- SiN demonstrated significant osteoconductive effect of hBM-MSC**
- However, **SiN** did not induce osteogenic differentiation of PDL-MSC
- Rough Ti** generated similar osteogenic differentiation for BM-MSC and PDL-MSC

## in vivo osseointegration



Implants placed in mouse femurs – osseointegration was measured by push in test at 1 and 3 weeks

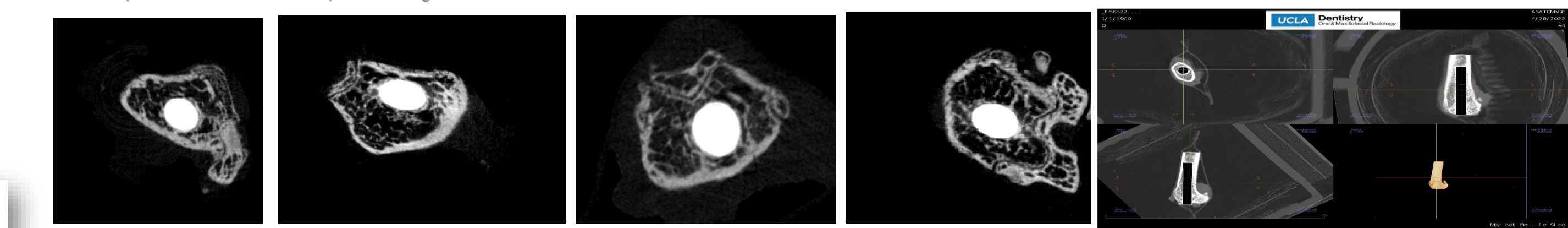
Implant Push in Test



SiN outperformed AE-Ti in the mouse implant osseointegration at week 3.

## MICRO CT

Micro CT Suggested bone formation around SiN Implants



## DISCUSSION

Osseointegration is a dynamic and complex process that involves different types of cells and different mechanisms.

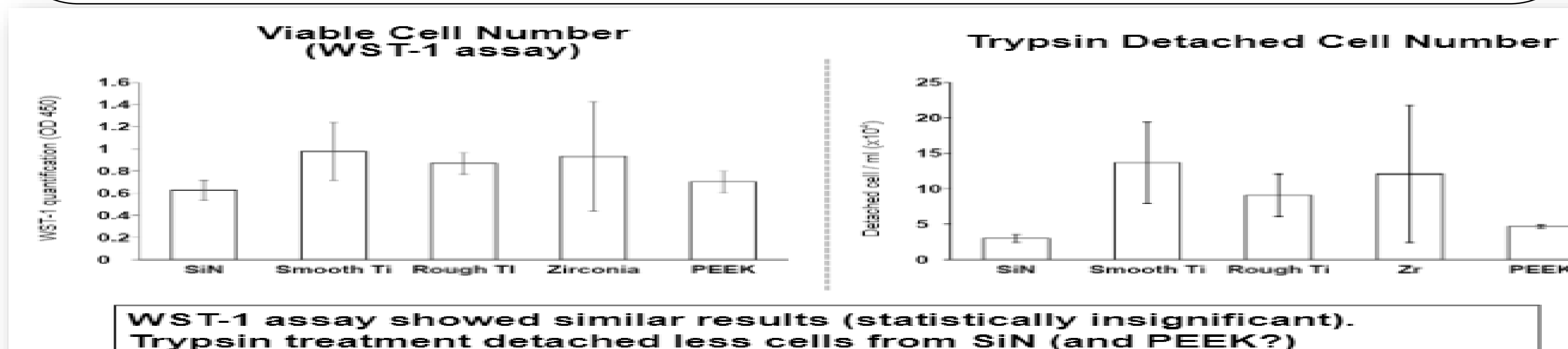
- Our in vitro study demonstrated a robust osteoconductive activity with SiN bioceramics.
- The in vivo study showed equivalent osseointegration activity by smooth surface SiN implant as compared to rough surface AE-Ti implant.
- SiN may be a potential novel dental implant material possessing strong osteoconductive activity

**ACKNOWLEDGEMENT:** This study was supported in part by SINTX Technologies, Inc.

## In vitro Cell Viability Assay

The effect of cell viability was evaluated via a WST-1 assay

- Human BMSC was cultured in osteogenic medium on discs  
There was no difference in cell viability among biomaterials tested.
- Adhesion molecules +  $Ca^{2+}$  determine cell-matrix interaction  
However, after trypsin treatment, cell recovery from SiN (and PEEK) was much less.  
Cell adhesion to SiN may be stronger than Ti and AE-Ti



WST-1 assay showed similar results (statistically insignificant). Trypsin treatment detached less cells from SiN (and PEEK?)

## In vitro mineralization assay

To evaluate the effects of multiple dental materials specifically on the in vitro mineralization of **BM (bone marrow derived)-MSC** and **PDL (periodontal ligament)-MSC**.

