



FunGlass

Centre for Functional and Surface Functionalized Glass

Alexander Dubček University of Trenčín

THE INFLUENCE OF TEST CONDITIONS ON ZINC RELEASE FROM THE 45S5 BIOACTIVE GLASS

A. Švančárková^{1,2}, D. Galusková¹, H. Kaňková¹, D. Galusek¹

¹FunGlass - Slovakia, ²FCHPT STU - Slovakia

e-mail: anna.svancarkova@tnuni.sk



INTRODUCTION

Interactions of bioactive glasses in an acidic solutions **simulating inflammatory environment** are studied to obtain picture about release of ions possessing antibacterial property.

Static tests designed primary for apatite forming studies

- local ion saturation
- increase in pH

Dynamic test designed to study kinetics of ion release

- possibility of monitoring the early dissolution reactions
- conditions close to human body

MATERIAL

45S5+4Zn

- fabricated by conventional melting
- particle size: $\leq 25 \mu\text{m}$
- surface (BET) = $a_{s, \text{BET}} : 4.964 \times 10^{-1} \text{m}^2/\text{g}$

Liquids used for tests

physiological
→ SBF(pH 7.4)= simulated body fluid

acidic environment
→ NaAc/HaAc(pH 4)= acetic acid / sodium acetate solution

| composition | 45S5+Zn | |
|-------------------------------|-------------|-----------------------|
| | Theoretical | Determined by ICP OES |
| SiO ₂ | 44.5 | 42.3 ± 2.4 |
| P ₂ O ₅ | 5.9 | 9.0 ± 3.1 |
| CaO | 21.4 | 21.7 ± 1.0 |
| Na ₂ O | 24.2 | 23.3 ± 2.1 |
| ZnO | 4.0 | 3.7 ± 0.8 |

* normalized to 100%

MOTIVATION

EXPERIMENTAL

OBJECTIVES

Asses the effect of:

- pH of solution
- test conditions

on release of Zn as an antibacterial ion



human plasma pH (7.4)



static conditions



inflammatory process pH (4)



dynamic conditions

METHODS

Static test

V (25 mL)
m_s (35 mg)

$$NL_i = \frac{c_i * V}{w_i * S}$$

37°C

Dynamic test

m_s-550 mg

$$NL_{i, \text{kum}}^i = (c_i \frac{F}{S} \Delta t) / w_i + NL_i^{t-\Delta t}$$

$$S = m_s * a_{s, \text{BET}}$$

NL_i-amount of the element released into the solution is normalized with respect to its content in corroded material (μg/cm²)

c_i- concentration of an element i (μg/L)

m_s- weight of sample(g)

F - flow rate (0.66x10⁻³ L/min)

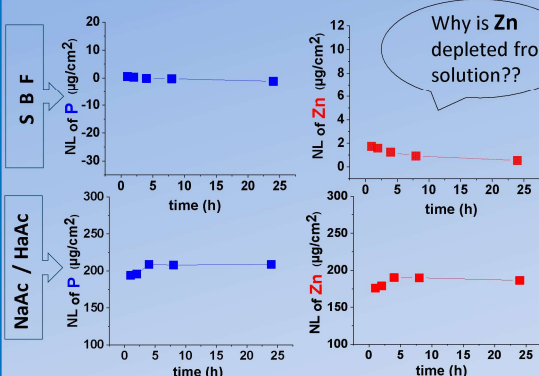
S - surface (cm²)

w_i- normalized mass fraction of an element i in the glass

V- volume of solution (L)

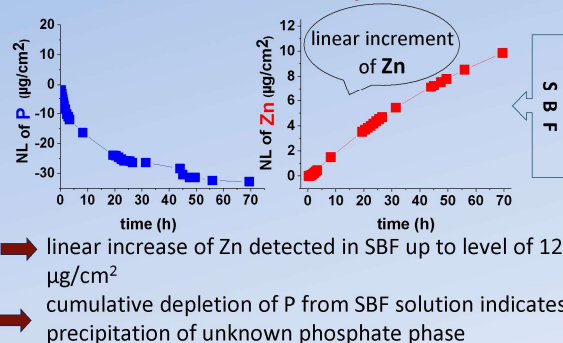
RESULTS

Release of Zn and P under static conditions



- depletion of Zn from SBF solution with time
- information about maximum amount of Zn released from bioactive glass not obtained from the static test
- in acidic medium the glass fully dissolved

Release of Zn and P under dynamic conditions



- linear increase of Zn detected in SBF up to level of 12 μg/cm²
- cumulative depletion of P from SBF solution indicates precipitation of unknown phosphate phase

OUTCOME

CONCLUSIONS

- Fast release of zinc determined for HAc solution – further testing suggested to asses its antimicrobial effect.
- The dynamic regime applying the flow rate 0.66 mL/min minimizes expected precipitation reactions and gives more accurate picture about the maximal amount of Zn released from potential bioactive glass comparing to static conditions.
- The dynamic tests are more suitable to address kinetics and to identify the maximum amount of released ions bearing therapeutic properties.

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