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# Assessment of hydroxyapatite coatings doped with silver and strontium through galvanostatic pulse technique

Elena Ungureanu[1,*], Diana Vranceanu[1], Alina Vladescu (Dragomir)[2], Anca Parau[2], Anisoara Cimpean[3], Cosmin Cotrut[1]

1 Faculty of Materials Science and Engineering, National University of Science and Technology Politehnica Bucharest, 313 Splaiul Independentei, 060042 Bucharest, Romania
2 National Institute of Research and Development for Optoelectronics INOE2000, 409 Atomistilor, 077125 Magurele, Romania
3 Department of Biochemistry and Molecular Biology, University of Bucharest, 91-95 Independentei Street, 050095 Bucharest, Romania

## INTRODUCTION & AIM

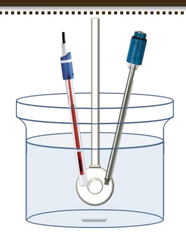
Hydroxyapatite coatings are a rapidly expanding field that focuses on addition of various elements to obtain tunable properties. The electrochemical techniques enable the assessment of coatings based on hydroxyapatite doped with various elements that promote cell growth and osteogenic differentiation while exhibiting antibacterial properties. The aim of this study was to obtain hydroxyapatite-based coatings doped with Sr and Ag through galvanostatic pulses technique.

## METHOD

### Sample preparation

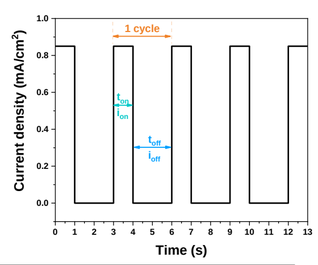
- SiC paper (230 ÷ 800 grit)
- Sonication in acetone

### Coating deposition



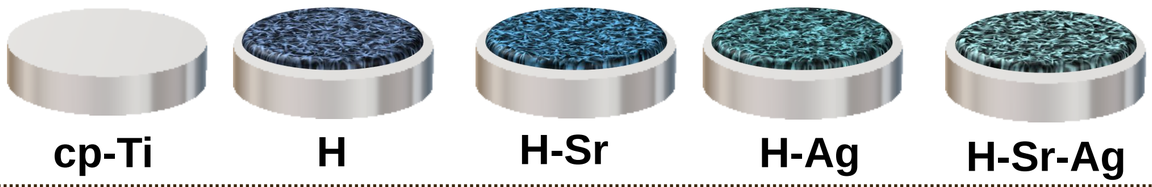
**Pulsed Galvanostatic Mode**

- 1 cycle:
  - $i_{ON}$ = 0.85 mA/cm² for 1 s
  - $i_{OFF}$ = 0 mA/cm² for 2 s
- 900 cycles



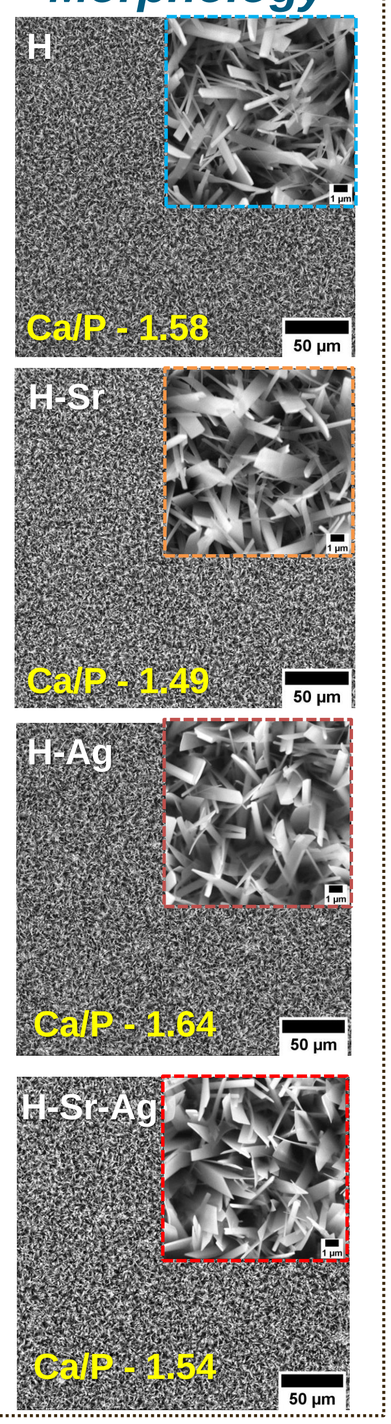

**Electrolyte**

| Substrate | | cp-Ti | | | |
|---|---|---|---|---|---|
| Codifications | | H | H-Sr | H-Ag | H-Sr-Ag |
| Chemical compositions (mM) | $Ca(NO_3)_2 \cdot 4H_2O$ | 10 | 9 | 9.98 | 8.98 |
| | $NH_4H_2PO_4$ | 6 | | | |
| | $Sr(NO_3)_2$ | - | 1 | - | 1 |
| | $AgNO_3$ | - | - | 0.02 | 0.02 |
| (Ca+M)/P, where (M=Sr/Ag) | | 1.67 | | | |




## RESULTS & DISCUSSION

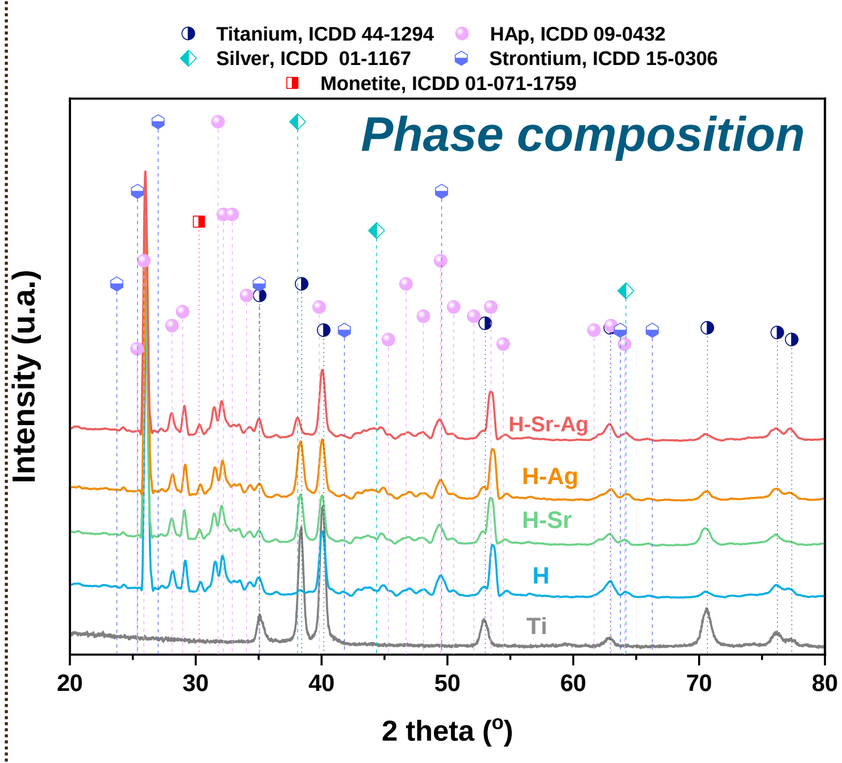
### Morphology




### Chemical composition

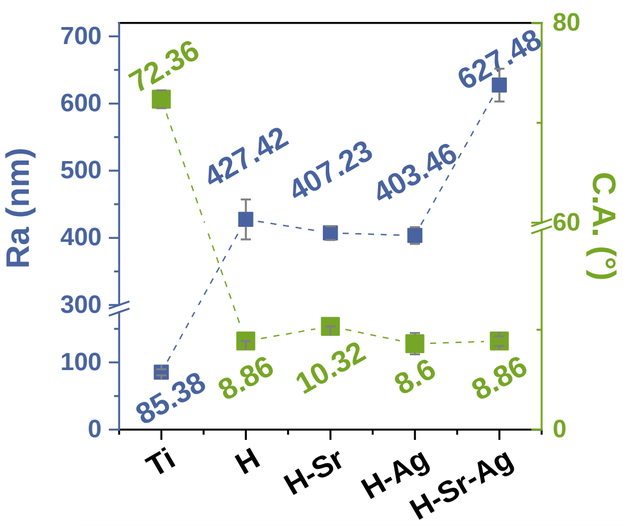
| Sample | Chemical composition (at.%) | | | | (Ca+M)/P (where, M=Sr, Ag, Sr+Ag) |
|---|---|---|---|---|---|
| | Ca | P | Sr | Ag | |
| H | 61.18 | 38.82 | - | - | 1.58 |
| H-Sr | 56.38 | 40.16 | 3.45 | - | 1.49 |
| H-Ag | 61.14 | 37.82 | - | 1.04 | 1.64 |
| H-Sr-Ag | 56.39 | 39.41 | 3.34 | 0.86 | 1.54 |

### Phase composition

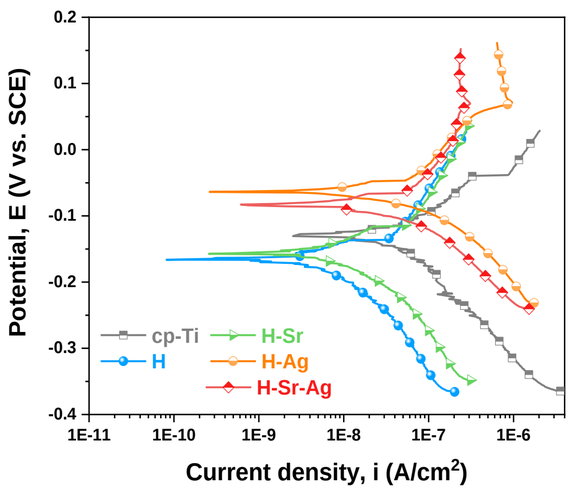



| Sample \ Parameters | Crystallite size d(nm) | Lattice constants a=b (Å) | Lattice constants c (Å) | Crystallinity (%) |
|---|---|---|---|---|
| H (#09-0432) | N/A | 9.418 | 6.884 | N/A |
| H | 26.11 | 9.423 | 6.865 | 46.92 |
| H-Sr | 26.68 | 9.446 | 6.876 | 50.10 |
| H-Ag | 26.19 | 9.426 | 6.867 | 47.36 |
| H-Sr-Ag | 26.57 | 9.445 | 6.888 | 49.49 |

### Roughness & Wettability

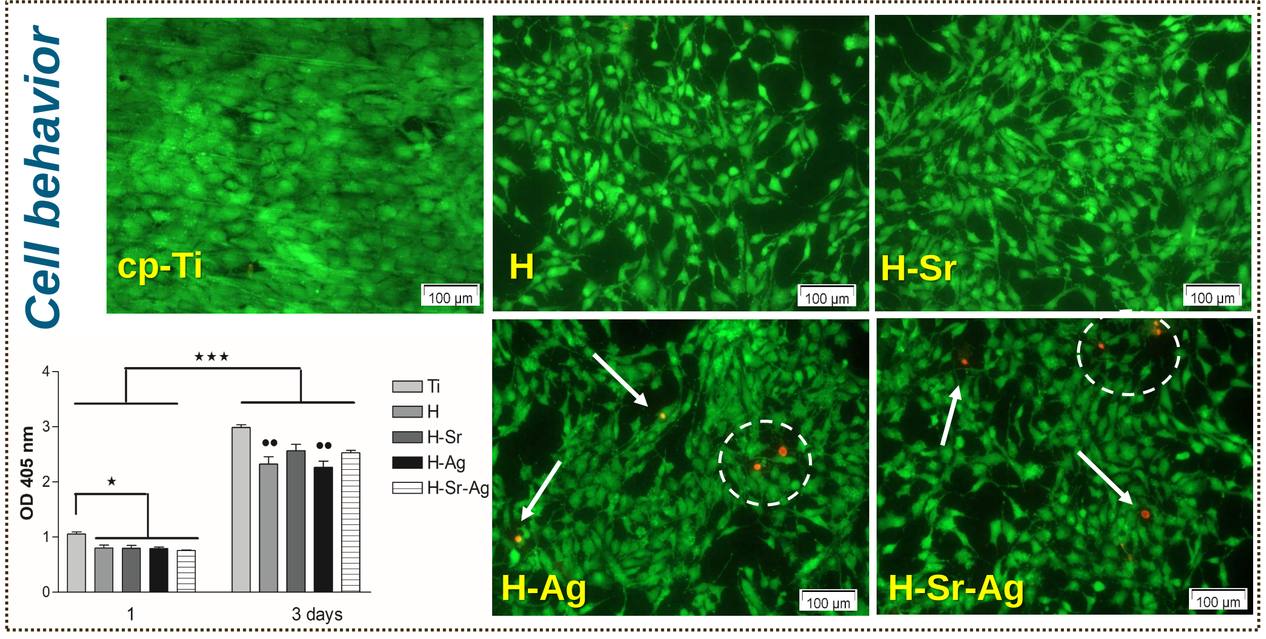



### Electrochemical behavior




| Samples | $E_{OC}$ (mV) | $E_{corr}$ (mV) | $i_{corr}$ (nA/cm²) | Rp (kΩxcm²) |
|---|---|---|---|---|
| cp-Ti | −170.38 | −129.79 | 83.54 | 390.24 |
| H | −171.07 | −166.24 | **18.07** | **2032.17** |
| H-Sr | −154.12 | −161.07 | 26.27 | 1391.28 |
| H-Ag | −37.88 | −63.20 | 52.63 | 525.20 |
| H-Sr-Ag | −46.93 | −84.42 | 48.63 | 672.12 |

### Cell behavior




## CONCLUSION

Thus, the undoped and doped hydroxyapatite coatings with strontium and/or silver obtained at *p*H 5 denoted enhanced and tunable properties for medical applications.