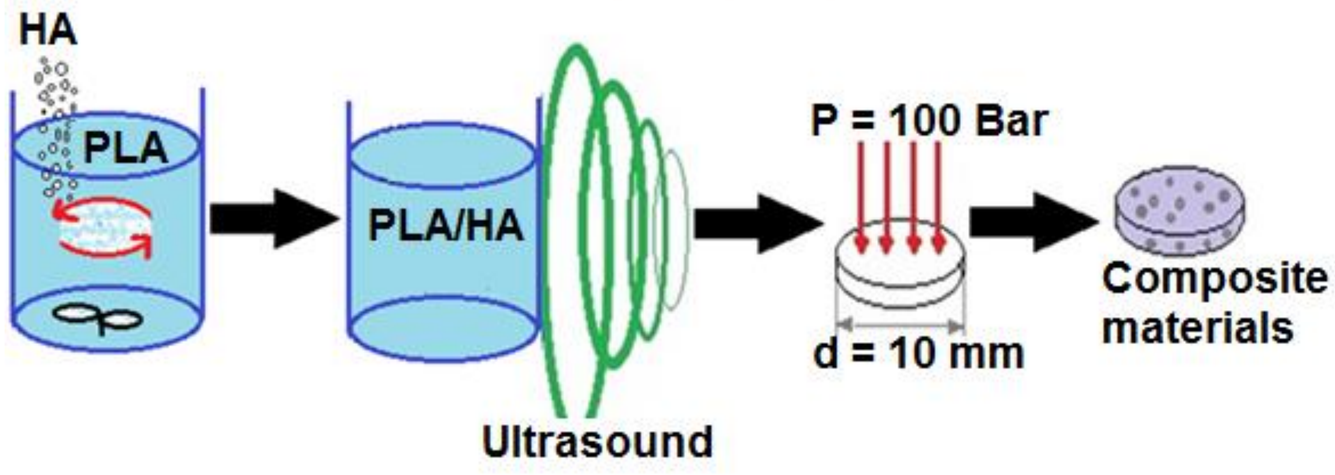
# ARGON LOW-TEMPERATURE ATMOSPHERIC PLASMA TREATMENT OF BIOCOMPATIBLE COMPOSITES BASED ON POLYLACTIC ACID AND HYDROXYAPATITE

***O.A. LAPUT***, I.V. VASENINA, M.O. KULIKOV, A.A. GRUSHEVSKAYA, K.P. SAVKIN, I.A. KURZINA
E-mail: olesyalaput@gmail.com

Biopolymers based of ***polylactic acid*** and ***hydroxyapatite*** (PLA/HA) are used in medicine to create immuno-tolerant prostheses, blood vessels, as well as in drug delivery systems and as implants for bond damage. As one of the ways to solve the problem of compatibility of the implant surface with the organism, it was proposed ***to modify the surface*** of biopolymers by low-temperature atmospheric plasma .

***The aim*** of this work is to research the effect of argon flow low-temperature atmospheric plasma treatment on surface physicochemical properties of biodegradable and biocompatible composites based on PLA and HA with the mass proportion of components 80/20, 60/40.

## PLA/HA sample preparation

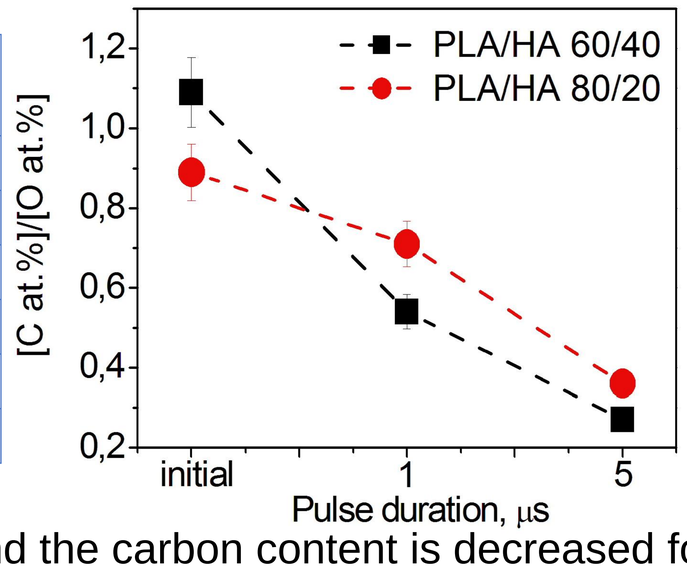



## Plasma treatment

| Processing conditions | Mode 1 | Mode 2 |
|---|---|---|
| Gas flow, l/min | 1 | 1 |
| Frequency f, kHz | 100 | 100 |
| Discharge voltage amplitude, V | 300 | 300 |
| Discharge current amplitude, mA | 40 | 40 |
| Pulse duration τ, μs | ***1*** | ***5*** |
| Temperature of plasma, °C | ***30*** | ***45*** |

## Elemental composition of PLA/HA

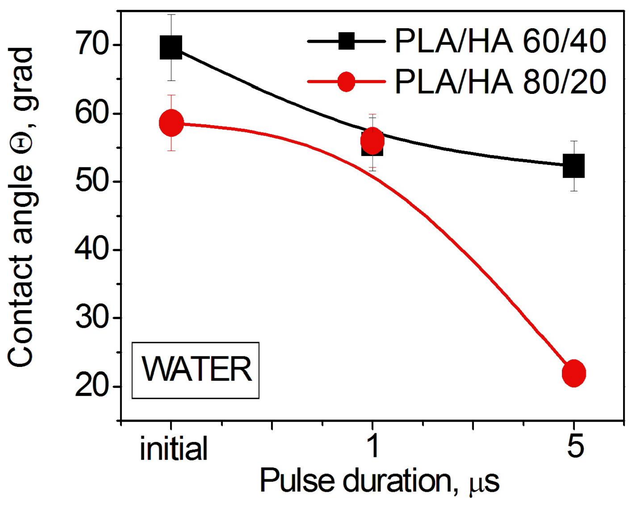
| | C1s | | | O1s | | Ca/P |
|---|---|---|---|---|---|---|
| Binding energy, eV | 285.0 | 286.9 | 289.06 | 532.25 | 533.66 | |
| PLA/HA 60/40 initial | 35.07 | 38.3 | 26.63 | 96.60 | 3.40 | 1.31 |
| PLA/HA 60/40 + 1 μs plasma | 63.40 | 19.35 | 17.25 | 95.11 | 4.89 | 1.33 |
| PLA/HA 60/40 + 5 μs plasma | 31.04 | 37.41 | 31.56 | 60.12 | 39.88 | 1.41 |
| PLA/HA 80/20 initial | 45.17 | 39.72 | 15.10 | 69.01 | 30.99 | 1.41 |
| PLA/HA 80/20 + 1 μs plasma | 62.58 | 23.04 | 14.37 | 69.21 | 30.79 | 1.39 |
| PLA/HA 80/20 + 5 μs plasma | 57.82 | 27.05 | 15.14 | 46.16 | 53.84 | 1.36 |

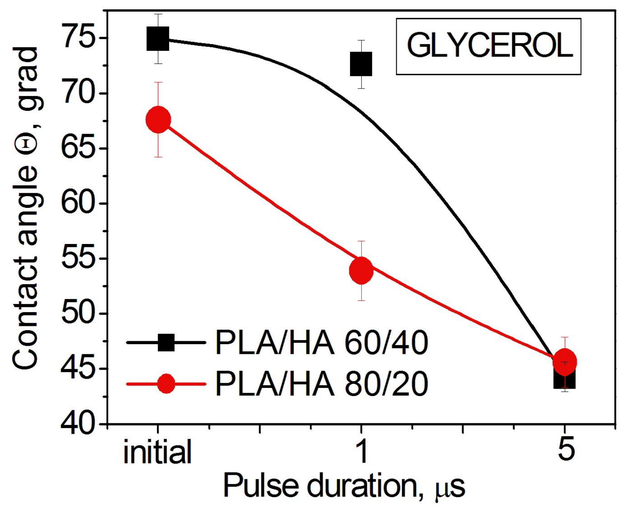


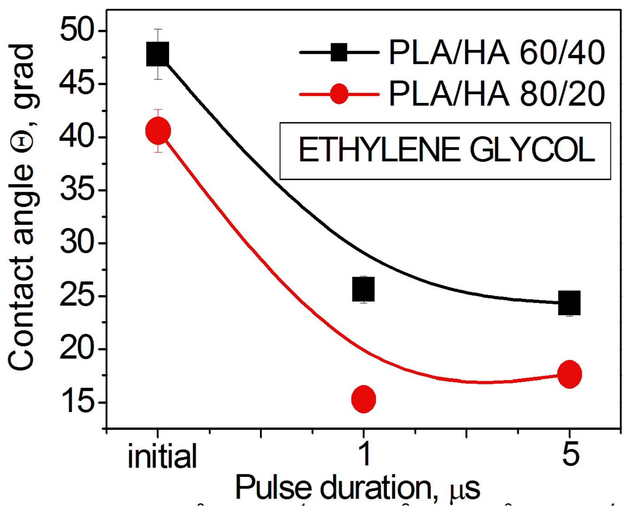

*The ratio of atomic concentrations C/O elements in PLA/HA, before and after plasma treatment.*

After plasma treatment the atomic concentration of oxygen is increased and the carbon content is decreased for both types of composites. This indicates that oxidative processes in the surface layer of the materials take place. The atomic concentrations of calcium and phosphate are increased. Therefore, polymer component of the composite material may have been evaporated or melted, while the more heat-resistant particles of hydroxyapatite are surfaced after plasma irradiation.

## Contact angle

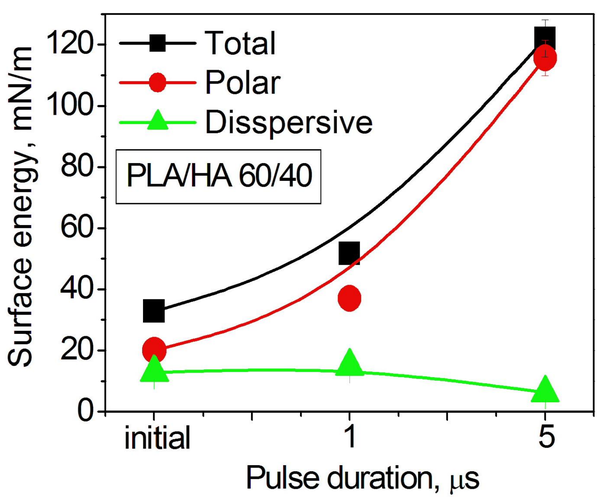


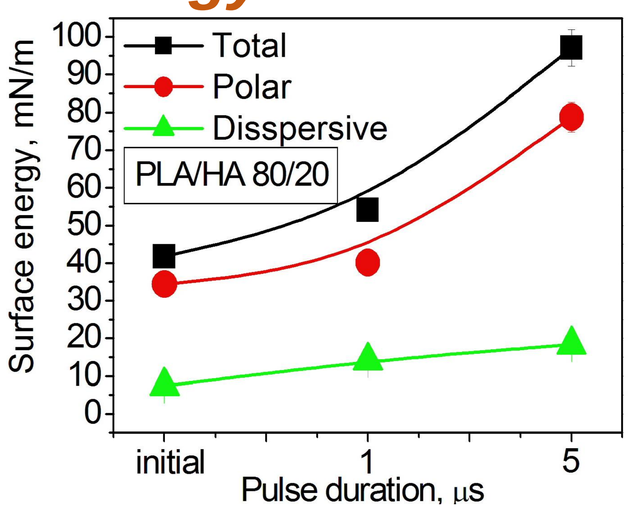




Wettability of the materials after plasma treatment is significantly improved, as evidenced by a decrease in the contact angle when wetted with water, glycerol and ethylene glycol.

## Free surface energy




Surface energy modification can significantly affect the bioavailability and surface cell absorption.

## Conclusion

Thus, it is shown that ***argon flow*** low-temperature atmospheric plasma treatment is ***an effective technique*** for surface ***physicochemical property*** modification of biocompatible composite materials based on polymer and non-organic matrix.

Work supported by the Tomsk State University competitiveness improvement program.