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The aim of the doctoral dissertation was to develop methods of modification of meta- and para-aramid textile structures, which will enable them to strengthen their resistance to UV radiation and give them multifunctional properties such as: hydrophobicity, electrical conductivity and antibacterial properties.

Aramid textile materials are not resistant to UV radiation. Therefore, in order to protect them, silver nanowires (AgNWs) were used for modification. However, AgNWs are subject to corrosion due to volatile sulfur compounds (e.g. sulfur dioxide, hydrogen sulfide, thiols) contained in the air. Silver nanostructures in direct contact with air are also slowly oxidized, especially in the presence of even small amounts of ozone. Therefore, it was important to protect AgNWs with a polysiloxane coating. The polysiloxane: poly-aminopropyl, dimethylsiloxane (PAPDMS), formed by hydrolysis and condensation of two silanes: 3-aminopropyltriethoxysilane (APTES) and diethoxydimethylsilane (DEDMS) was used for the modification. AgNWs with polysiloxane retains the ability to protect against UV radiation more effectively than the pure AgNWs.

The chemically inert and smooth surface of aramid fibers is difficult to modify, therefore the yarn treatment in low-pressure air RF plasma was applied. This allowed the removal of preparation. The roughness increased, which increased the contact surface between AgNWs and aramid. Polar functional groups formed on the surface of the fibers, which increased the surface wettability and AgNWs-aramid interactions.

The AgNWs modification of yarns was unstable, because after washing the nanowires were removed from the surface of the fibers. Therefore, in the next stage of the research, after plasma treatment the application of a polydopamine coating was made.

The results of the SEM analysis showed that under the influence of UV radiation, silver nanowires are degraded into silver nanoparticles. Therefore, new methods of functionalisation of aramid fabrics with AgNWs and polysiloxane have been developed:

- the one-step method (so-called *mixture*) in which silver nanowires were dispersed in PAPDMS sol and then applied on the aramid fabric;
- the two-step method (so-called *layer by layer*), in which polysiloxane was applied to the previously deposited AgNWs on the aramid fabric.

As a results of the study, the characterisation and the effects of aramid yarns and fabrics modifications were tested using UV-VIS, FTIR and Raman spectroscopy, SEM/EDS analysis, ASA analysis, DSC and TG/DTG thermal analysis, wettability and surface free energy measurements.

The specific strength of the meta- and para-aramid yarns were 32 cN/tex and 130 cN/tex, respectively. After 96 h of UV radiation, the specific strength of unmodified meta-and para-aramid yarns decreased, respectively by 49% and 47%. The specific strength of the irradiated yarns, after 5-folds of the AgNWs application, was 16% higher for meta- and 12% for para-aramid yarn than for the UV-radiated unmodified yarn. After 10 applications, there was a further increase (up to 26%) for the meta- and a 14% decrease for para-aramid yarn.

For fabrics, the specific strength of unmodified meta- and para-aramid fabrics was 8.6 N/tex and 38.7 N/tex, respectively. After UV radiation the specific strength decreased by 48% i 60%, for unmodified meta- and para-aramid fabric. For UV-irradiated AgNWs modified fabrics, the specific strength was higher by 42% and 52%, respectively, in relation to the unmodified UV radiated fabrics. After the *mixture* and *layer by layer* modification, the specific strength values were higher by 73% and 64%, respectively for the meta- and by 102% and 110% for para-aramid fabrics.

The linear electrical resistance (R_p) of the unmodified meta-and para-aramid yarns were 1.15×10^{12} Ω and 1.38×10^{12} Ω, respectively. After 10 times of AgNWs application, the R_p was 2.0×10^{4} Ω and 2.2×10^{4} Ω for meta- and para-aramid yarns respectively. After washing, the R_p for both yarns increased to 10^{10} Ω, which proves that the modification is not resistant to washing.

The electrical surface resistance (R_s) of the both unmodified fabrics is 1.3×10^{12} Ω. After AgNWs application, the R_s value decreased to 9.9×10^{2} Ω and 9.4×10^{2} Ω for meta- and para-aramid fabric, respectively. For fabrics after *mixture* and *layer by layer* modifcation, it decreased to 3.4×10^{4} Ω and 1.5×10^{3} Ω for mata- and to 7.7×10^{4} Ω and 1.4×10^{3} Ω for para-aramid fabric.

The electrical volume resistance (R_v) for unmodified fabrics was 1.3×10^{12} Ω and 1.1×10^{12} Ω for meta- and para-aramid fabric, respectively. After AgNWs application the R_v value was lower and amounted 9.4×10^{2} Ω oraz 9.0×10^{2} Ω, respectively. After the *mixture* and *layer by layer* modification, the electrical volume resistance decreased to 2.6×10^{4} Ω and 1.1×10^{3} Ω for meta- and to 2.9×10^{3} Ω and 1.1×10^{3} Ω for para-aramid fabric.

After washing, the R_s value for meta- and para-aramid fabric with AgNWs increased to 4.7×10^3 Ω and 1.9×10^3 Ω, respectively. In turn, the R_v value increased to 2.0×10^3 Ω for meta- and didn't change for para-aramid fabric ($R_v = 8.2\times10^2$ Ω). The fabrics were still conductive and the modification was resistant to washing. In the case of fabrics modified with the *mixture* and *layer by layer* method, the R_s values increased to 3.4×10^{11} Ω and 1.9×10^{11} Ω for meta- and to 2.0×10^{11} Ω and 1.4×10^{11} Ω for para-aramid fabric. The R_v for meta- and para-aramid fabric increased to 5.6×10^3 Ω and 1.4×10^3 Ω for *mixture* method and to 7.9×10^5 Ω and 1.1×10^4 Ω for *layer by layer* method. The fabrics modified with AgNWs and polysiloxane lost their Surface conductive properties, because $R_s > 10^6$ Ω, but retained the cross-conductivity. This proves the presence of AgNWs between the fibers, inside the fabric structure.

The water contact angle (Θ_W) for unmodified fabrics was 64 deg and 77 deg for meta- and para-aramid fabrics, respectively. After the AgNWs application, fabrics showed poor wettability, because the values of the Θ_W was 87 deg and 89 deg, respectively. The presence of polysiloxane caused an increase in the Θ_W value, which was respectively 125 deg and 120 deg after modification with *mixture* method and 112 deg and 114 deg for the *layer by layer* method. The surface free energy for unmodified meta- and para-aramid fabric was 40 mJ/m^2 and 54 mJ/m^2, respectively. After modifications the surface free energy for meta- and para-aramid fabrics was lower and amounted respectively: 33 mJ/m^2 and 34 mJ/m^2 after AgNWs application, 29 mJ/m^2 and 26 mJ/m^2 after *mixture*, and 29 mJ/m^2 and 28 mJ/m^2 after *layer by layer* method modification.

All modified aramid yarns and fabrics had antibacterial properties against *Staphylococcus aureus (Gram+)* and *Klebsiella pneumoniae (Gram-)* bacteria.

The studies have shown that developed modified multifunctional aramid textile structures have application potential in many industries, including: automotive, defense, textile for the production of protective clothing for high-risk professions and in a number of specialized applications for monitoring vital functions or the level of available oxygen, and as conductive and thermally conductive elements resistant textiles cooperating with a number of other sensors.