# ANTIVIRAL AND ANTIBACTERIAL SILVER/PVA COATING BY SPRAY AND ELECTROSPINNING

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**Abstract:** Noble metals (like silver) have been known for their broad-spectrum antimicrobial activity. The ongoing resistance of bacteria to antibiotics led to a resurgence of such old technologies in the form of nanotechnology that exhibits high efficacy against bacteria and viruses [1,2].
This work reports the results on antiviral and antibacterial properties of AgNPs dispersed in polyvinyl alcohol (PVA) matrix against SARS-CoV-2, *Escherichia coli* and *Staphylococcus aureus.* The protective coating was applied on textiles as a layer by spray-coating and as nanofiber mats by electrospinning.
AgNPs at 0.1 % w/w (synthesized as reported in [2]) were dispersed in water solutions of PVA (molecular weight 130 kDa, hydrolysis degree >99 %) at the volume ratio 1:1. PVA concentrations were 1 % w/v for spraying and 15 % w/v for electrospinning.
**Spray-coating**. The substrates used were 16-µm polypropylene (PP) spun-bonded non-woven (23 g/m$^2$), polyamide 6,6 (PA) plain fabric (59 g/m$^2$), and polyethylene terephthalate (PET) fabric (130 g/m$^2$). The substrates were cut into squares of 20×20 cm. Spray coating was performed using 5 mL of AgNPs/PVA dispersion on vertically fixed specimens. The coated specimens were dried in an oven at 80 °C for 2 minutes. Figure 1 shows the treated PP substrate.

**Figure 1** AgNPs/PVA spray-coated PP substrate.

Washing tests were performed according to ISO 105-C06 at 40°C for 30 minutes with ECE detergent for 10 repeated cycles. Abrasion tests were performed according to ISO 12947-2 with 12 kPa loading for 1000 abrasion cycles.

**Electrospinning.** AgNPs/PVA dispersions were electrospun using an electrospinning plant with a high-voltage generator connected to a metal tip, a metering pump feeding the solution to the metal tip and a flat metal collector (50×50 cm) connected to a second high-voltage generator. The PP spun-bonded non-woven was cut into squares of the same size as the collector and stuck on it.
Adding AgNPs destabilized the electrospinning, producing multiple jets (Figure 2a) instead of a single jet from the metal tip as usual. Therefore, the AgNPs/PVA dispersion was processed at voltages of +30 kV at the tip and -5 kV at the collector. Each deposition lasted 1 h and covered an average surface of 448±33 cm$^2$ (Figure 2b). The AgNPs/PVA nanofibers were treated in an oven at 155°C for 3 minutes to fix the nanofibrous porous structure and stabilize it to water contact for 24 h (Figure 2c).

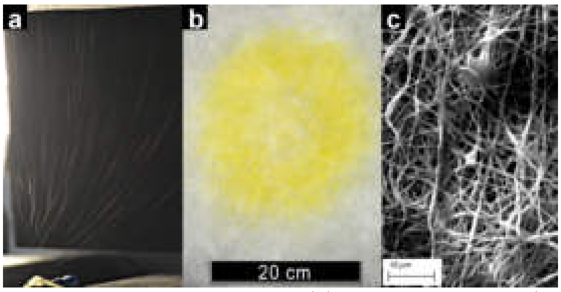


**Figure 2** Electrospinning process (a). Electrospun AgNPs/PVA nanofibers mats on PP substrate (b). SEM picture of electrospun AgNPs/PVA nanofibers after contact with water (c).

**Antibacterial and antiviral testing.** The virucide activity against SARS-CoV-2 of AgNPs/PVA spray-coated PP substrate was reduced by 33 % compared to the untreated substrate. AgNPs/PVA spray-coated substrates showed 100 % bacterial reduction (*E. coli* and *S. aureus*). The coating was stable for washing (10 cycles) and abrasion (1000 cycles), resulting in bacterial reductions of 85-90 % and 95-99 %, respectively.
AgNPs/PVA electrospun nanofibers showed bacteria reductions of 99.6% against *S. aureus* and 100% against *E. coli*.

***Keywords:*** *silver, spray-coating, electrospinning, antibacterial, antiviral.*

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## REFERENCES

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