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Effect of PEDOT:PSS with secondary dopants and DBD plasma treatment on the conductive properties of polyester fabrics

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Introduction

Smart textiles have the capability to interact with the surrounding environment and react in different ways, namely in electrical conduction. The conductive properties of these materials are useful in medical, healthcare, and protective clothing. Poly(3,4-ethylene dioxythiophene):polystyrene sulfonate (PEDOT:PSS) is one of the most widely used polymers to enhance the conductivity of materials. Withal, the addition of dopants can improve its conductivity by expanding the polymer chains. Glycerin (GLY) works as a plasticizer by lowering the glass transition temperature, enhancing homogeneous distribution of PEDOT. Dielectric barrier discharge (DBD) plasma treatment is an environmentally friendly method that can be applied as a pre-treatment of fabrics to increment the adhesion of coatings. DBD plasma-activated polyester (PES) fabric was functionalized with PEDOT:PSS and GLY as dopant.

Methodology

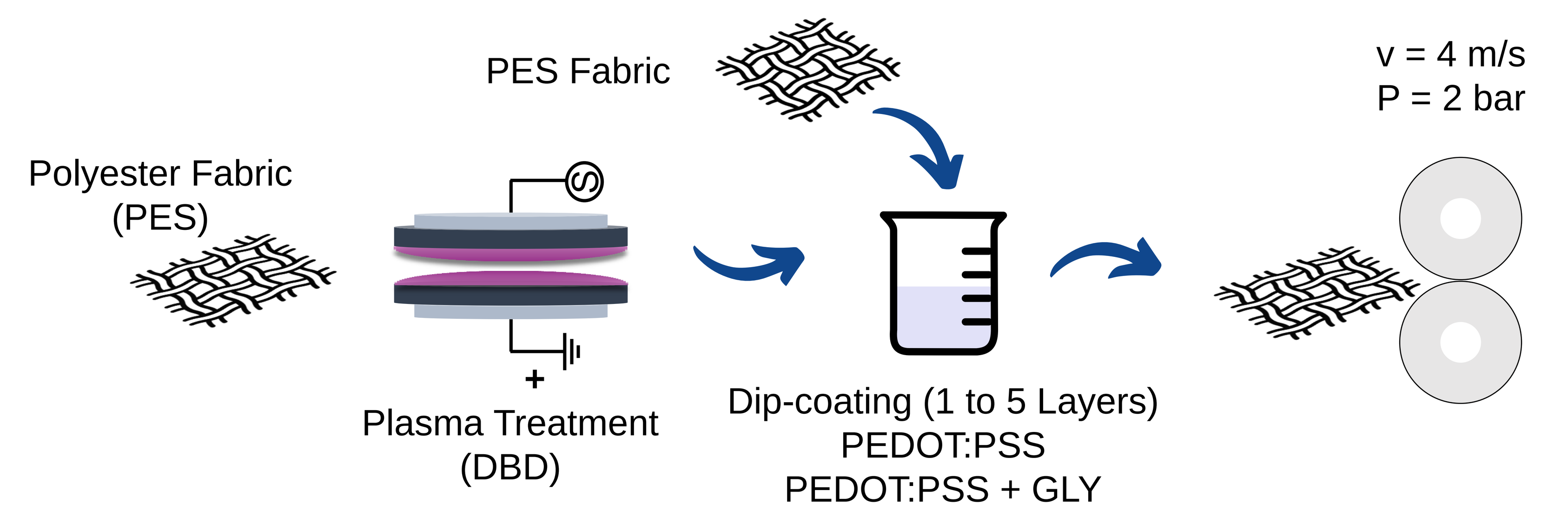

Figure 1. Methodology applied for the functionalization of PES fabrics with PEDOT:PSS.

Results and Discussion

Electrical conductivity (**Figure 2**) using a 4-point probe test:

- ❑ Higher number of PEDOT:PSS layers results in higher conductivity values;
- ❑ The incorporation of GLY further increased the conductivity values of the samples

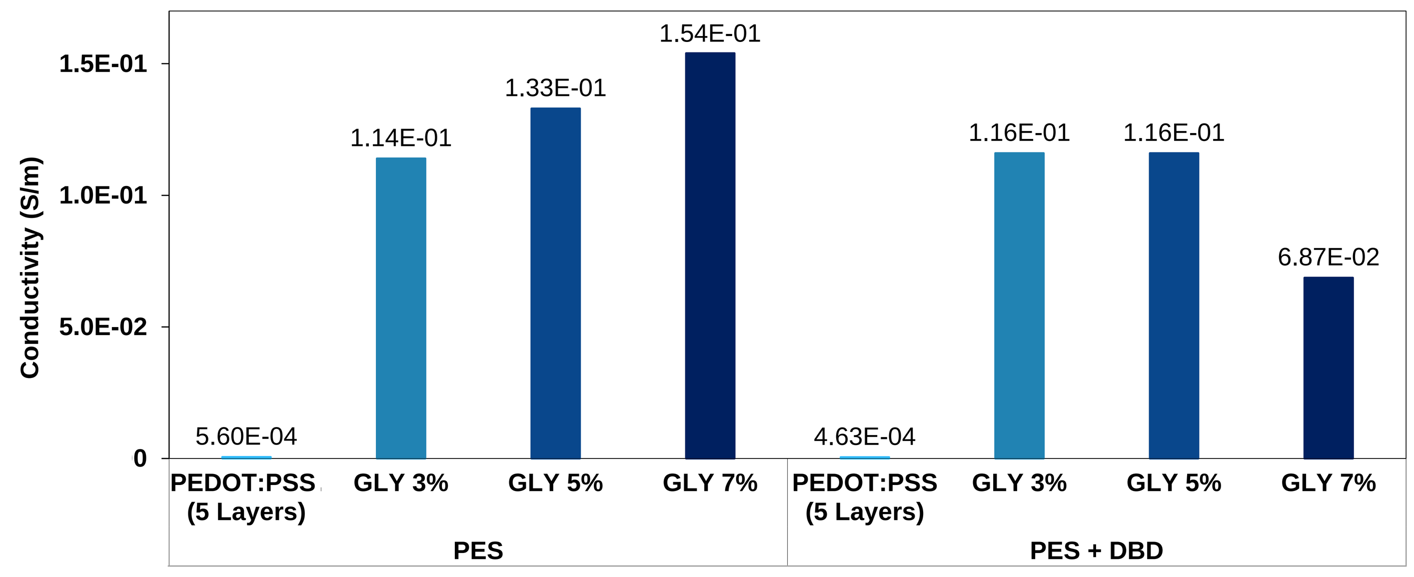

Figure 2. Electrical conductivity of coated samples with PEDOT:PSS and GLY in different concentrations, obtained while applying a voltage of 6.5 V and 2 cm spacing between probes.

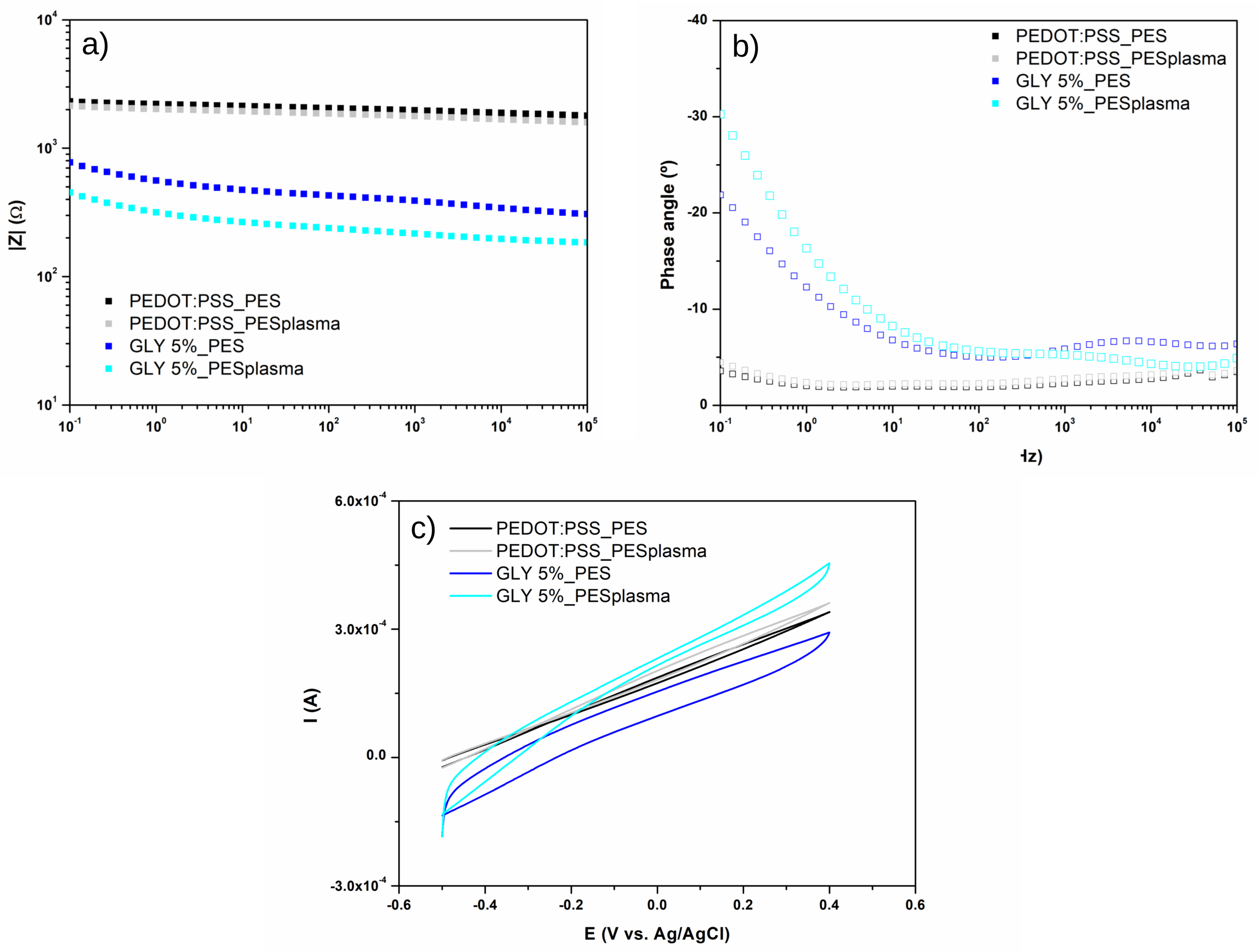

Figure 3. a) Bode diagrams of electrochemical impedance of the prepared samples; b) Bode diagrams regarding phase angle of the studied samples; c) Cyclic voltammogram obtained in a aqueous solution of sodium chloride.

The joule effect test (**Figure 4**) has shown that:

- ❑ By applying a voltage of 6 V, the temperature increased 5.3 ˚C and 4.6 ˚C, after 60 minutes, for untreated and plasma-treated samples, respectively;
- ❑ The application of a voltage of 12 V raised the temperature by 14.6 ˚C and 22.4 ˚C after 60 minutes, for untreated and plasma-treated samples, respectively;
- ❑ Plasma treatment increased the capacity of the samples to transform the supplied electrical energy into thermal energy;
- ❑ The addition of GLY led to higher temperatures comparing with PEDOT:PSS alone.

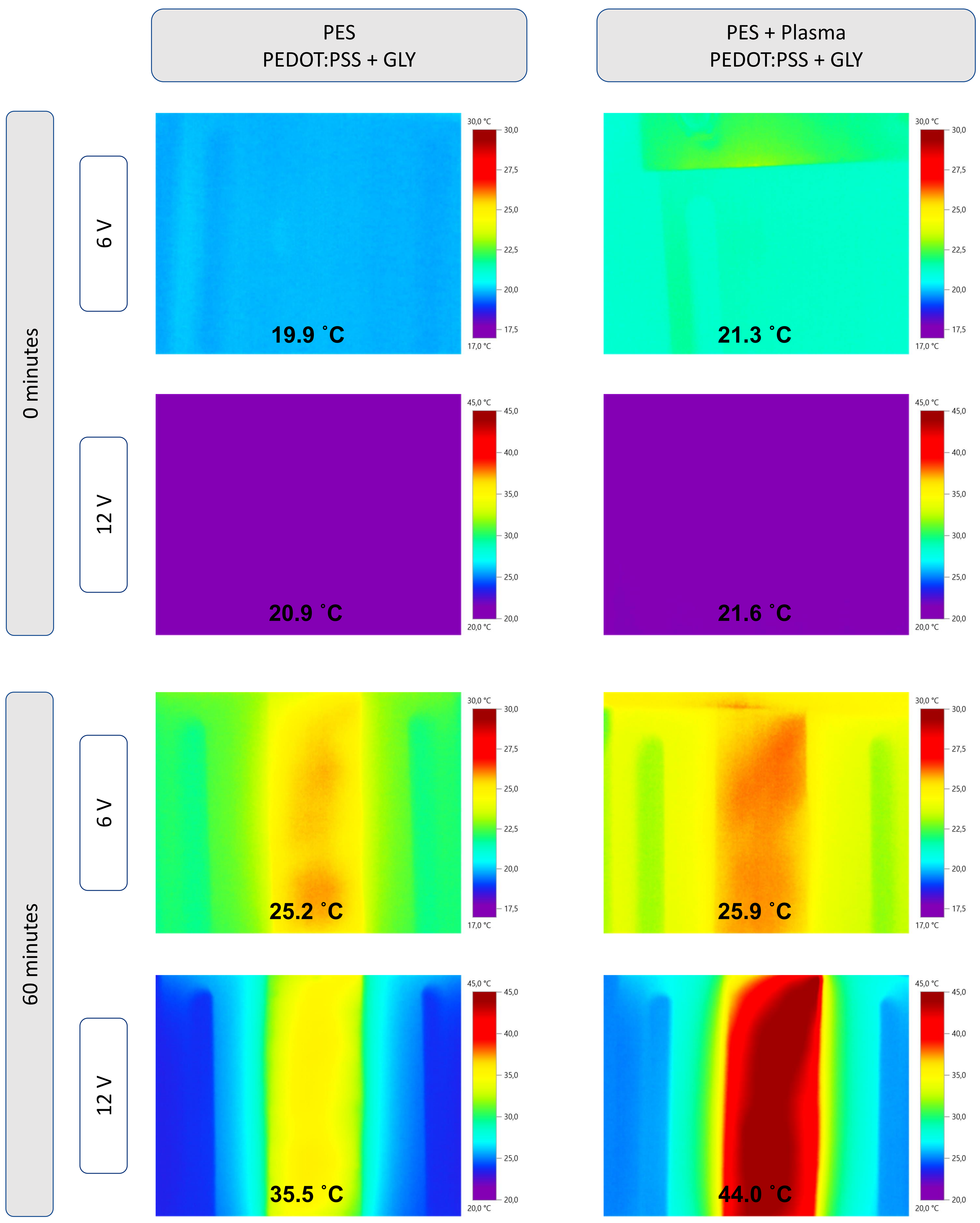

Figure 4. Thermal images of PEDOT:PSS and GLY while applying voltages of 6 and 12 V.

Conclusions

- ❑ Optimal electrical conductivity values were achieved with 5 layers of PEDOT:PSS and 5% of GLY;
- ❑ Samples reached higher temperatures while applying 12 V of voltage;
- ❑ Plasma treatment increased the conversion rate of electrical to thermal energy;
- ❑ Usage of both plasma and GLY lowered the resistivity of the samples;
- ❑ Samples coated with GLY as a dopant behaved more as capacitors.

Acknowledgments

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