MATERIALS RESEARCH CENTRE
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Characterization and Optimization of Novel Polymer Composite PEDOT:DBSA for Bioelectronic Applications

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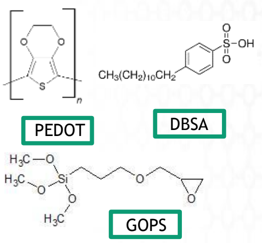
Introduction

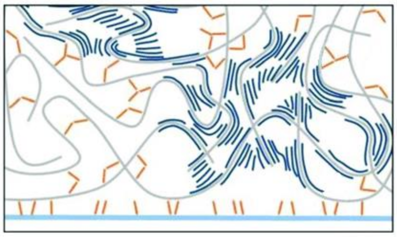
The unique properties of organic conducting materials give rise to many next generation bioelectronic devices, utilized especially in the fields of medicine and personalized treatment. PEDOT (poly(3,4-ethylenedioxythiophene)) doped with PSS (poly(styrenesulfonate)) is an organic polymer, which currently plays a main role in such applications. Nevertheless, recent research has shown minor cytotoxicity of the material attributed to the PSS moiety, whose sulfonate groups restrict cell adhesion.

The aim of this work was to introduce new conducting materials based on PEDOT, with improved properties compared with PEDOT:PSS. For this purpose, PEDOT doped with **DBSA** was studied and its properties were optimized.

Increasing the long-term stability of PEDOT:DBSA

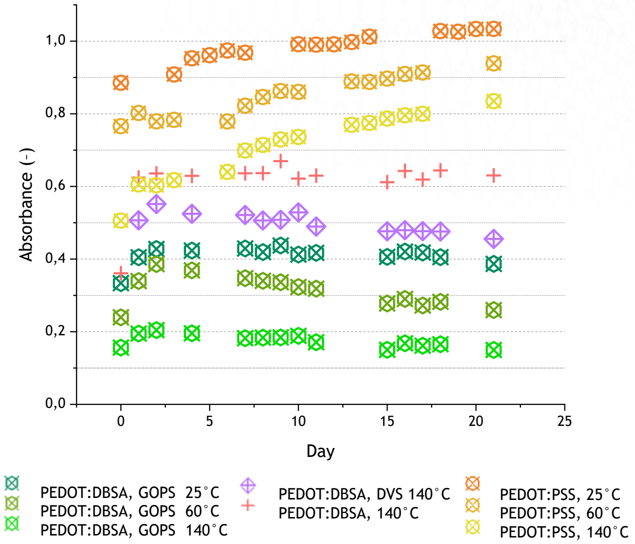
- Cross-linking agents GOPS and DVS were used
- Methoxysilane and epoxy groups of GOPS can react with many different functional groups – GOPS is able connect the polymer chains together, as well as with the glass substrate
- High temperatures (140 °C) are usually used for the crosslinking activation and the conductivity of the polymer is usually reduced – to see the influence GOPS on electrical conductivity of PEDOT:DBSA, see poster of Šárka Tumová





Delamination test, MTT assay

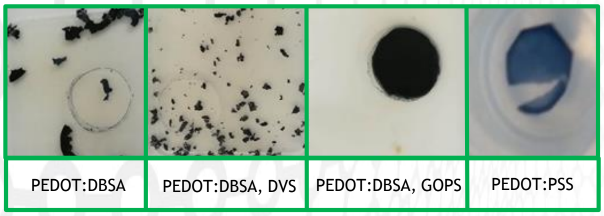
The delamination test of the thin films of pristine and cross-linked PEDOT:DBSA was carried out to study the long term stability of the films in aqueous media. Crosslinking of some samples was induced by heating (60 and 140 °C) as well as over time (72 hours). PEDOT:PSS film was used as a reference. Samples were immersed into distilled water and the resistance of the films against delamination, redispersion and dissolution was studied during 21 days.



The graph shows that pristine PEDOT:DBSA possesses better long-term stability than pristine as well as heated PEDOT:PSS. Moreover, it can be further improved by cross-linking with GOPS, showing significantly reduced dissolution.

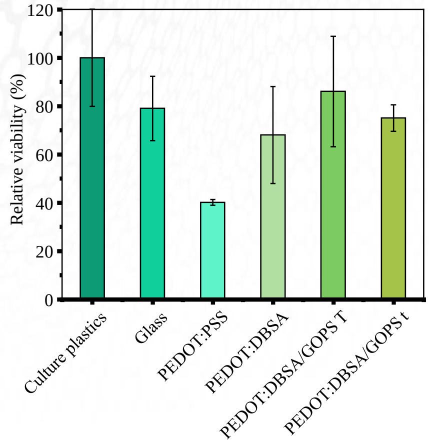
Even better resistance against dissolution was noticed for thermally treated samples, however with untreated samples the dissolution was observed only in the beginning of the experiment. This suggests that multiple rinse of the films before immersion should prevent any noticeable material release into the solution. This indicates the possibility to obtain sufficiently stabilized PEDOT:DBSA without the need of higher temperatures. Unlike for PEDOT:DBSA, higher temperature is necessary to stabilise PEDOT:PSS.

As alternative cross-linker for PEDOT:DBSA we used DVS, however samples with DVS were not able to prevent delamination of the film from the glass substrates.



The MTT biocompatibility assay was performed to study the viability of murine 3T3 fibroblasts on pristine and crosslinked PEDOT:DBSA, using PEDOT:PSS as a reference. The cells grown on pristine PEDOT:DBSA showed almost **twice as high relative viability** in comparison with PEDOT:PSS. The use of crosslinker GOPS has further positive effect on the biocompatibility of the material, observed for both, samples stored at the room temperature (**t**) and thermally treated samples (**T**).

Moreover, the relative viability obtained for the heated sample reaches up to 90 % of standard plastic control and relative viability observed for the unheated sample is equal to the one detected on the glass substrate, therefore both films proved to be very suitable substrates for the cell growth. PEDOT:DBSA also proved enhanced biocompatibility compared to other organic semiconductors often used in bioelectronic devices, therefore, PEDOT:DBSA shows a great potential to form an interface with living organisms.



Conclusion

A delamination test was performed to study the resistance of the films against delamination, redispersion and dissolution. It was observed that PEDOT:DBSA possesses better long term stability than PEDOT:PSS and can be further improved by cross-linking, forming almost water-resistant films without a need to use higher temperatures during its preparation. Standard MTT biocompatibility assay was performed to determine materials biocompatibility towards murine fibroblasts. Pristine PEDOT:DBSA showed almost twice as high relative biocompatibility as PEDOT:PSS and both cross-linked samples even higher, reaching the values of standard glass dish and up to 90 % of plastic dish. Therefore, PEDOT:DBSA proved to be a more suitable material for use in bioelectronic devices than the currently most widely used organic material for this purpose – PEDOT:PSS.

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