ACRYLAMIDE BASED ORGANOGEL ELECTROLYTS

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Advantages

- ! Directly obtained from polymerization
- ! Intrinsic ionic functionality
- ! High ionic conductivity
- ! Multi-ion organogel electrolytes possible

Organogel synthesis

The organogel electrolyts consists of three main components, namely potassium 6-acrylamidohexanoic acid (6-AAUK), *N,N*-dimethylacrylamide (DMAA) and the cross-linking agent tetraethylene glycol diacrylate (TTEGDA). To improve certain properties, different additives, such as polyethylene glycol monomethylether acrylate (Mod) and polyethylene glycol -block-polypropylene glycol (ICN), were added. The organogels can be polymerized thermally at 80°C or via UV curing. This makes it possible for 3-D printing, which has previously been accomplished.

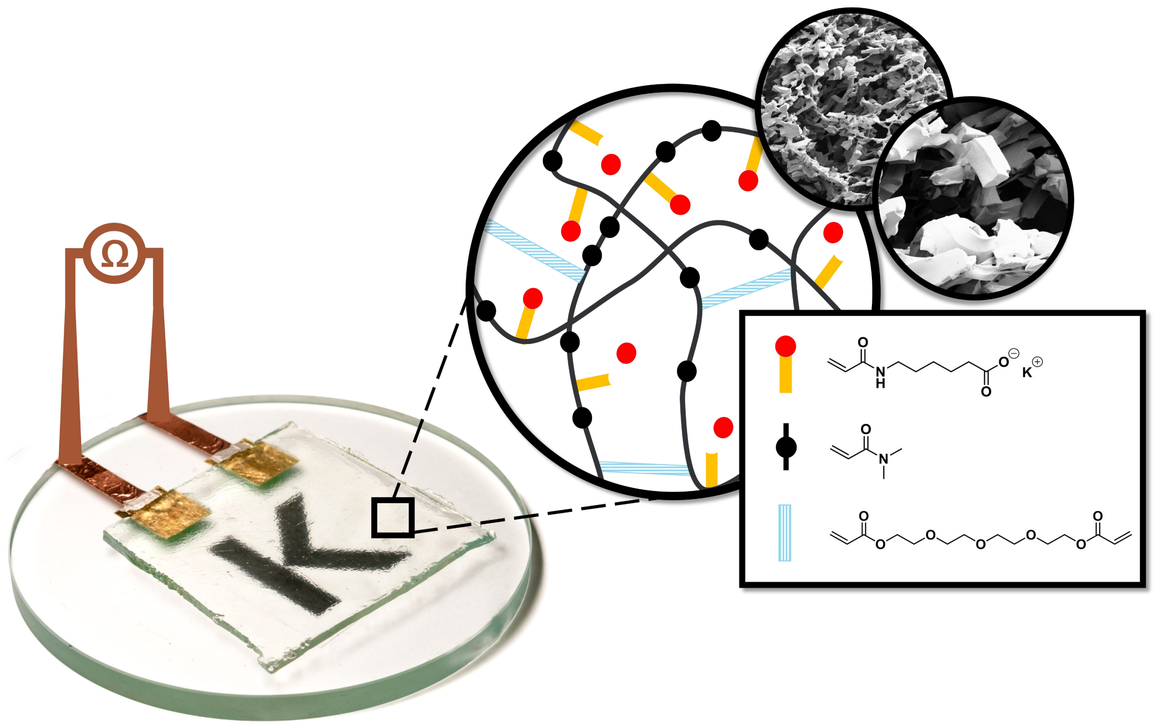

Figure 1: Picture of a synthesized acrylamide-based organogel electrolyte with gold electrodes connected to a copper foil by silver conducting paste (left) and in closer inspection the structure of the gel containing 6-AAUK, DMAA and TTEGDA in the solvent ethylene glycol (right). Scanning electron microscopy pictures in the circles with a diameter of 500µm (behind) and 100µm (front).

Ionic Conductivity

The ionic conducitvity is a main feature of organogel electrolytes. It was measured using Electrochemical Impedance Spectroscopy. In Figure 2 and 3, the results of five different organogels are illustrated. 6-AAUK and DMAA were mixed in different molar ratios and TTEGDA was kept constant. To modify the tensile strength and conductivity, a polyethylene glycol based polymer (Mod) was mixed into four gels. The intercalating network (ICN) was added to the mixture with the aim to achieve higher conductivity.

In conclusion, the ionic conductivity of the organogel electrolytes is enhanced by the addition of ICN and a decreased solids content.

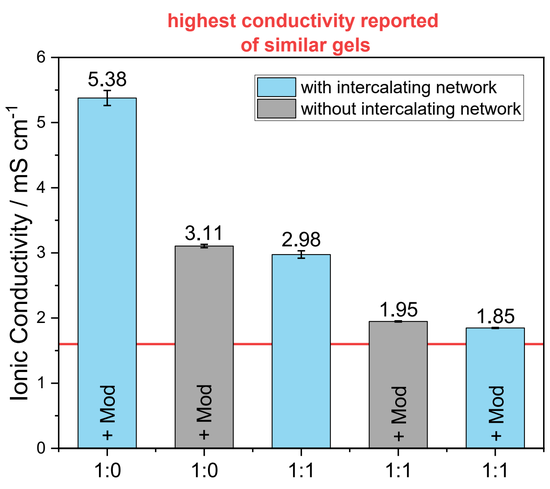

Figure 2: Ionic conductivity of 5 organogel electrolytes with the different compositions in reference to literature.[2]

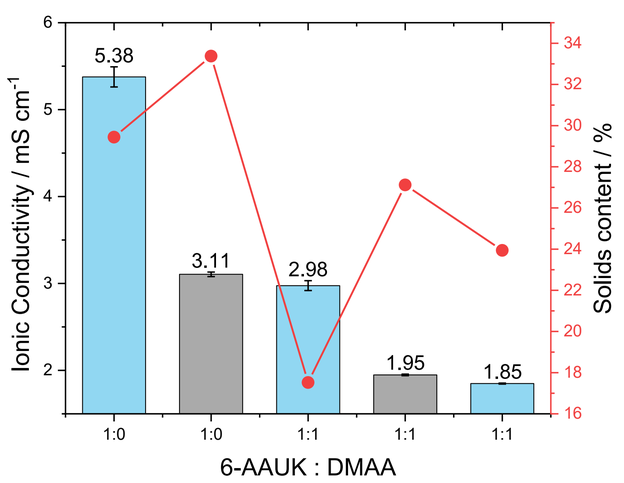

Figure 3: Relationship of the ionic conductivity and the solids content of the organogel electrolytes.

Tensile measurements

Tensile measurements were performed to identify the mechanical stability of the synthesized organogels. The gels were measured in dog bone shape.

The highest values were measured for a gel with the following composition: equimolar 6-AAUK to DMAA, 12mol% Mod and 15vol% ICN, resulting in a ultimate strain and stress of 84.7 ± 2.7 % and 11.25 ± 1.13 kPa, respectively (Figure 5).

Pictures of an organogel electrolyte before elongation and before breakage are shown in Figure 4.

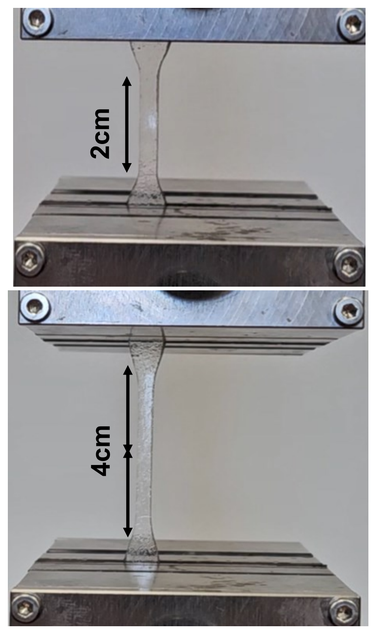

Figure 4: Picture of the organogel during the tensile measurement; upwards: before the elongation, downwards: elongation before breakage. Performed with a Zwick Roell according to DIN 527-4.

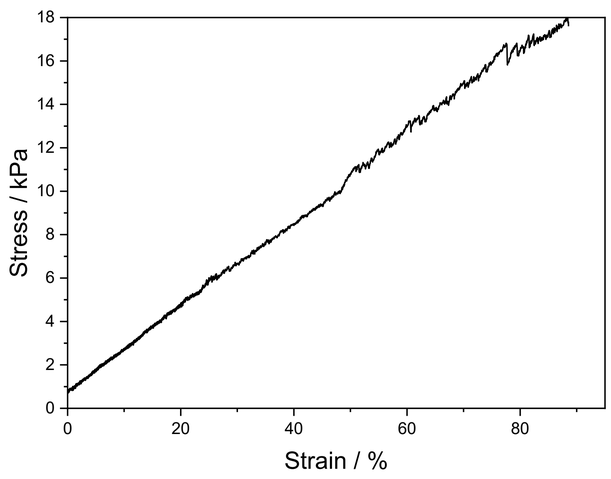

Figure 5: Strain versus stress of the organogel with the highest measured values.

Conclusion

- Water-free organogel electrolytes
- High ionic conductivites up to 5 mS / cm^{-1}
- Higher conductivity with ICN
- Strain up to 85 %

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References

[1]Chatterjee J., Liu T., Wang B., Zeng J.P. Highly conductive PVA organogel electrolytes for applications of lithium batteries and electrochemical capacitors *2010*, 181(11), 531-535.