

Hydrophobic deep eutectic solvent based on decanoic acid and tetrabutylammonium bromide: characterization and evaluation towards electrode modification

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Highlights

Eutectic point determination of decanoic acid and tetrabutylammonium bromide mixtures, Improved analytical response for hydroquinone detection using an electrode modified with the eutectic mixture.

Abstract

Deep eutectic solvents (DES) emerged as a new category of green solvents able to substitute hazardous organic ones. Since then, these solvents have been broadly studied due to their outstanding features, such as biodegradability, non-volatility, and low toxicity¹. Understanding the characteristics of DES has supported further applications of this new class of solvents contributing to the development of sustainable procedures^{2,3}. In this context, this work aimed to investigate the synthesis of a hydrophobic deep eutectic solvent based on decanoic acid (DecA) and tetrabutylammonium bromide (TBAB) and its application as a modifier of a new electrochemical electrode. Several DecA:TBAB hydrophobic mixtures with different molar ratios were prepared and subsequently characterized by differential scanning calorimetry (DSC), to determine the eutectic point of the system. In short, the DecA:TBAB composition of 1.5:1 (mol/mol) (named HEM – hydrophobic eutectic mixture) presented the lowest melting temperature ($-7.63\text{ }^{\circ}\text{C}$, **Fig. 1(a)**), indicating that this composition resulted in the eutectic mixture. Furthermore, FTIR studies were conducted to evidence the interactions between these precursors. From the FTIR spectra (**Fig. 1 (b) (c) and (d)**), one can highlight the shift in the stretching vibrational band of the decanoic acid carboxyl group from 1693 cm^{-1} to 1724 cm^{-1} due to interactions with tetrabutylammonium bromide. These results agreed with NMR results. To finish, HEM was mixed with multi-walled carbon nanotubes (MWCNT) and NafionTM forming a suspension to modify a glassy carbon electrode (GCE). Hydroquinone (H_2Q , 1.0 mmol L^{-1}) was used as a redox probe to evaluate the electrochemical response of the proposed electrode. According to the cyclic voltammograms (**Fig. 1 (e)**), HEM enhanced the analytical response for H_2Q , with a 1.63 and 1.20-fold increase in the anodic and cathodic currents, respectively, compared to the MWCNT/GCE (without HEM). In addition, **Fig. 1 (e.i)** shows a decrease in the peak-to-peak separation potential (ΔE_p) for HEM-MWCNT/GCE electrode; ΔE_p to the electrode modified with HEM was 1.45 and 1.38-fold lower than those for GCE and MWCNT/GCE electrodes, respectively. The outcomes demonstrated in this work indicate that the proposed hydrophobic eutectic mixture is promising for developing new electrochemical electrodes. Also, the complete characterization achieved can support an understanding of how the eutectic solvents' interactions are formed.

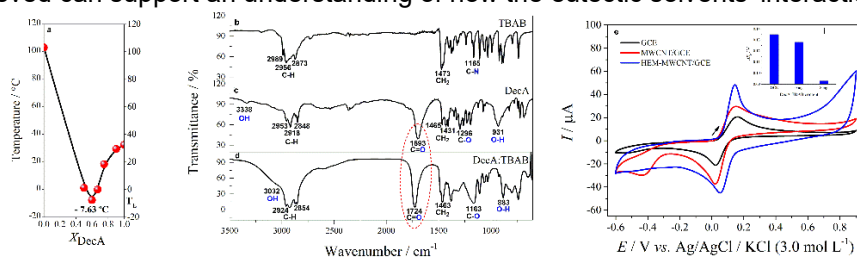


Figure 1 – Eutectic phase diagram of the system DecA:TBAB (a). FTIR analysis for the eutectic mixture and its components: (b) TBAB, (c) DecA, and (d) DecA:TBAB (HEM). And cyclic voltammogram at (—) GCE, (—) MWCNT/GCE, and (—) HEM-MWCNT/GCE electrodes scan rate of 50 mV s^{-1} (e). Inset: Peak-to-peak separation potential of the proposed electrodes.

¹Zhang et al. *Chem Soc Rev* **41**, 2012; ²Augusto et al. *Analytical Methods* **14**, 2022; ³Piton et al. *J Braz Chem Soc* **32**, 2021.

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