Phospholipids (PLs) are important biological compounds that have application in various industries. It is well known that the acyl chain length of PLs influences the crystal-to-liquid transition temperature (Tm) [1], which is an important property that influences uses of PLs. Understanding the molecular dynamics of anhydrous PLs below the Tm can potentially shed light on their intrinsic behaviour in living systems and in industrial applications. TSDC is an important technique that can be used to obtain such information, by means of molecular relaxation processes, at temperatures below the Tm.

Thermally Stimulated Depolarisation Current (TSDC) as a Novel Analytical Approach for the Study of Anhydrous Phospholipids

**INTRODUCTION**

The phosphatidylcholines (PCs) 1,2-dilauryl-sn-glycero-3-phosphocholine (DLPC), 1,2-dimyristyl-sn-glycero-3-phosphocholine (DMPC), 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC) and 1,2-distearoyl-sn-glycero-3-phosphocholine (DSPC) of >99% were kindly provided by Lipoid (Germany), and dehydrated in-situ (Dehydration was confirmed by thermogravimetric analysis (TGA). Samples are placed between two parallel electrodes and polarised at 90°C for 2 minutes using 350 V/mm in the TSDC experiments covering the temperature -25 to 100°C. For TW experiments conditions were Ep = 400 V/mm at Tp of -20 to 60°C in increments of 3°C (Tw = 3°C, tw = 2 min).

**RESULTS and DISCUSSION**

The global TSDC curves (Fig.2 (a)) contain information of the overall molecular relaxation process which is indicative of molecular mobility. The results demonstrate, for the first time, that anhydrous PCs undergo significant molecular mobility at temperatures below their Tm. The temperature of relaxation current maxima was found to increase with increasing carbon chain length (Fig. 2 (b)). This shows that increasing carbon chain length requires an increase in heat energy to initiate molecular motions in PCs. Both, molecular mobility below Tm and Tm for series of PCs show correlation between measured values (Tmax in TSDC and TM in DSC) implying that carbon chain length plays an important role in structural arrangements, flexibility and mobility of PC's molecules (Table 1).

The TW results (Fig. 3a-d) shows several discrete relaxation processes within the global TSDC curve. The respective distribution of relaxation times for the isolated processes (Fig. 3e-h) are generally straight and were fitted with the Arrhenius equation. The relaxation time (τ) of the isolated relaxation process with the highest current generated is used to compare the molecular mobility characteristics of the PCs (Table 1). The relaxation time for the PCs in general increases with increasing carbon chain length, which implies a more sluggish molecular mobility as you increase carbon chain length, that is due to increased hydrophobic interaction and viscosity. On the other hand, activation energy of molecular relaxation decreases with increasing carbon chain length. This observation is attributed to difference in the degree of ordering in the materials. PCs in the solid-state are semi-crystalline (confirmed by XRPD) and it is likely that PCs with longer carbon chain length will have greater state of mobility of their chains involved in formation of an amorphous fraction.

**MATERIALS and METHODS**

**CONCLUSIONS**

The application of TSDC has provided novel information pertaining to anhydrous PCs below their Tm. This study has demonstrated that significant molecular mobility exist below the Tm and the temperature at which mobility occurs increases with carbon chain length. Relaxation rate is also more sluggish for PCs with longer carbon chain length. These offer some explanations as to why increasing carbon chain length of PCs increases their physical stability. TSDC therefore enhances capabilities in understanding physical stability of materials by analysing relaxation processes in materials that occur at temperatures well below any structural change.

**REFERENCES**
