Ionic Liquids GC Columns and their Applications

The variety of available stationary phases for gas chromatography (GC) has been fairly constant for many years. Recent research and development has established unique materials that play an important role in GC column technology. They are ionic liquids (ILs).

Ionic liquids can be defined as a class of solvents with low melting points that consist of organic cations associated with anions that can be either inorganic or organic. These compounds exhibit ideal properties for a stationary phase in gas chromatography such as very low vapour pressure and high thermal stability.

They are attractive for use as GC stationary phases due to these favourable properties:

- Very low volatility, resulting in columns with lower bleed and longer life
- In liquid state over a wide temperature range, providing extended temperature ranges
- No active hydroxyl groups at their termini; providing resistance to damage from moisture and oxygen
- Inherently highly polar; allowing lower elution temperatures plus an increased selectivity for polarizable analytes
- The broadest range of physical-chemical solvation interactions, giving the columns their unique selectivities.

Our US scientist Dr. Frank Michel and his team evaluated this application of new dicationic liquids as stationary phases, and found improvement in efficiency and temperature stability of such phases. This work, which focused on a new stationary phase for GC with a polarity similar to PEG or Wax phase, is presented in the following page:

Evaluation of a New Ionic Liquid Stationary GC Phase with PEG/Wax-Like Polarity.
Evaluation of a New Ionic Liquid Stationary GC Phase with PEG/Wax-Like Polarity


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Introduction
Ionic liquids are a class of solvents with low melting points that consist of organic cations associated with (inorganic or organic) anions (Fig. 1). These compounds exhibit ideal properties for a stationary phase in gas chromatography such as very low vapor pressure and high thermal stability [1]. The unique selectivity and the high thermal stability of the new phase allowed the development of improved GC separations for these applications.

Results & Discussion
Classification of Ionic Liquid GC Phases:
In order to obtain a single parameter for the comparison of conventional and ionic liquid GC phases a polarity scale based on a suggestion of Prof. Luigi Mondello, University of Messina, Italy, was developed. Each column is characterized with a series of five probes plus several n-alkane markers to determine the retention index for each probe. McReynolds Constants are then calculated using the retention index data of the column relative to the retention index data for the same five probes on squalane, the most non-polar GC stationary phase. The five McReynolds Constants are summed up to obtain Polarity (P) values, which are then normalized to SLB-IL100 (set at P=100) to obtain Polarity Number values (Fig. 2).

Fig. 1: Structure of Ionic Liquid used as stationary phase for SLB-IL100

Fig. 2: Positions and maximum temperatures of non-ionic liquid and ionic liquid GC phases

To get a better understanding of the selectivity on Ionic Liquid GC phases a test mixture containing aromatic, aliphatic and polar compounds was investigated at isothermal conditions. The more polar a stationary phase is the stronger polar compounds are retained and non-polar compounds not (Fig. 3).

Fig. 3: Comparison Ionic Liquid GC columns (30 m x 0.25 mm, 0.20 µm). Oven: 110 °C, Inj.: 250 °C, Det.: FID, 250 °C, Carrier gas: helium, 26 cm/sec, Injection: 1.0 µL, 100:1 split. Sample in isooctane (listed in boiling point order): Toluene, Ethylbenzene, p-Xylene, Isopropylbenzene, Cyclohexanone, 1,2,4-Trimethylbenzene, 1,2,4,5-Tetramethylbenzene, n-Tridecane (C13)

An Ionic Liquid phase with polarity value of 60 is similar to polarity of a wax phase. A new phase was developed with polarity of 60, high inertness for alcohols and improved maximum temperature (Fig. 4-6).

Fig. 4: Separation of C1-C12 n-alcohols at 110 °C isothermal on SLB-IL60.

Fig. 5: Separation of C1-C12 n-alcohols at 110 °C isothermal on SLB-IL60.

Summary
Ionic Liquid GC columns provide advantages in terms of selectivity, maximum temperature and column stability and life time. SLB-IL60 especially offers improved inertness compared to similar Ionic Liquid phases, different selectivity at the same polarity compared to PEG/Wax phases and higher maximum temperature and lower bleed than PEG/Wax phases. SLB-IL60 can be used for a wide variety of applications (data not shown).

References