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Halogen-free pyrrolidinium bis(mandelato)borate ionic liquids: Some physicochemical properties and lubrication performance as additives to polyethylene glycol

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Abstract

This work reports on the synthesis and physicochemical characterisation of novel halogen-free boron containing ionic liquids (hf-BILs) with dialkylpyrrolidinium cations [CnC1Pyrr]+, n = 4-14, and bis(mandelato)borate anion [BMB]-. All the synthesised compounds are liquids at room temperature. It was found that the thermal properties and density of these hf-BILs are affected by the length of the longest alkyl chain connected to the nitrogen atom in the pyrrolidinium cations. Differential scanning calorimetry measurements revealed that glass transition temperatures of these ionic liquids are in the temperature range from 218 to 241 K. Interestingly, the glass transition temperatures follow the "odd-even" effect related to the number of carbons (n) in one of the alkyl chains of [CnC1Pyrr]+. It was also found that hf-BILs' density decreases with an increase in the alkyl chain length of [CnC1Pyrr]+. It is suggested that the "odd-even" effect is associated with the difference in packing and specific interactions of cations and anions of this class of hf-BILs. Their lubricating properties, as 3 wt% additives in polyethylene glycol (PEG), were evaluated in steel-steel contacts. PEG with hf-BILs additive provided significantly lower wear and friction compared to the neat PEG and 5W40 engine oil. It was found that shortening the length of the longest alkyl chain in the cations of [CnC1Pyrr][BMB] significantly reduces frictional losses. Antiwear properties of [CnC1Pyrr][BMB] in PEG follow the same trend. This journal is © the Partner Organisations 2014.

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