Sone pe Sohaaga – Icing on the Cake

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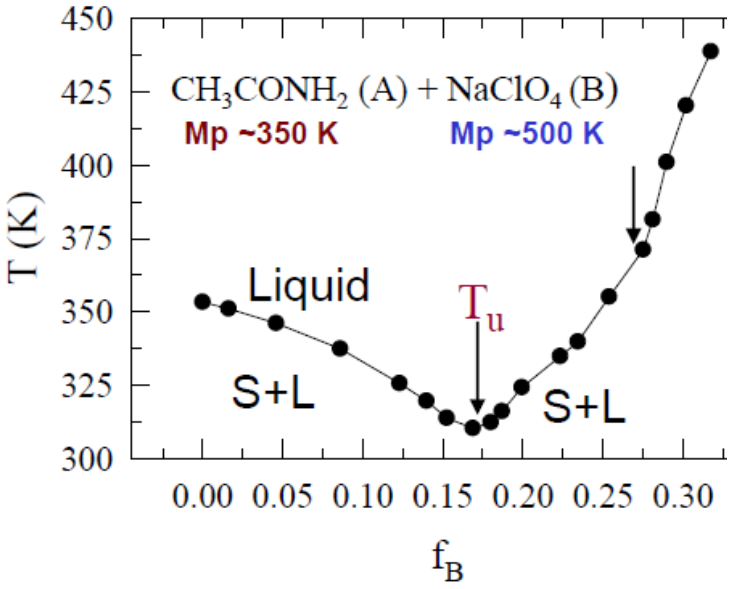
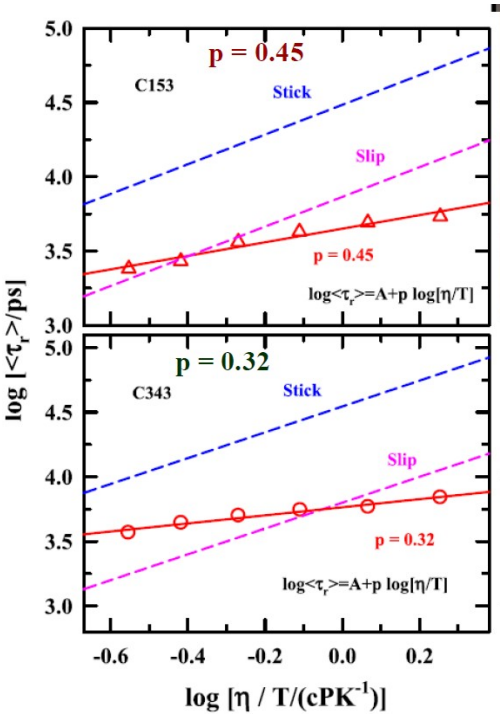
All of us are familiar with the proverb '*Sone pe Sohaaga*'- aren't we? What exactly this means? In English, the closest to this is '*Icing on the cake*' or '*Cherry on top*'. Broadly, this proverb means additional benefit to something that is already considered positive or beneficial. For food, this indicates addition of taste or aroma enhancer; insertion of an appropriate stone to a pendant could do the same to the beauty of an attractive necklace. But you wonder what this has to do with science? Yes, it has a lot to do with science!The action hermitically expressed in this canindeed generate a huge interest among chemical engineers who look for accessing, through liquid solvent engineering, new environment friendly reaction media for large scale industrial applications as well as basic science researchers who searches for non-uniformity inside seemingly uniform distributions. Let us elaborate a bit with some examples.

Many of us have witnessed local goldsmiths, using a wax lamp and blow-pipe, trying to melt something by directing the lamp light on a target plate via controlled yet intense blowing. What was done there was simple melting of gold ornaments by mixing with a known amount of *sohaaga* or borax. The use of *sohaaga*or borax for melting gold is known for more than 100 years. Borax, whose chemical formula is $Na_2B_4O_7.10\ H_20$, melts at around 1000 K. Gold melts at around 1300 K. Interestingly, when gold is sprayed with the right proportion of borax and heated the mixture melts at around 850 K! Then this molten mixture was used to refine gold by following a process known them. Note here the mixture melts at a temperature much lower than the melting temperature of both gold and borax. This depression of melting point is a source for preparation of a new class of solvents known as deep eutectic solvents, and a manifest of colligative property often read in Physical Chemistry. The figure below explains this deep depression of melting or freezing point.



This figure shows that addition of an electrolyte, sodium perchlorate ($NaClO_4$) to an organic compound, acetamide (CH_3CONH_2) can bring down the melting temperature near to room temperature. The beauty of these 'deep eutectic solvents' is that they remain as a stable liquid at that eutectic temperature (T_u) even after removing the heat source. The number of such combinations are practically limitless as innumerable compounds are available that are capable of, on right combinations, producing deep eutectic solvents (DESs) with desired physicochemical properties. In addition, they are less hazardous to handle and transport because the parent components are solid. One may even find biodegradable components to produce room temperature DESs. Indeed we have produced two such DESs and studied the basic physical chemistry aspects. They are (i) glucose-urea-water DES[1] and (ii) betaine-urea-water DES.[2] In both these media we found, via time-resolved spectroscopic measurements, strong deviation from the simple inverse proportionality relationship between the diffusion process and viscosity of the medium. A representative figure depicting this for the glucose containing DES is shown below.



Refs:

1. "*Interaction and Dynamics in a Fully Biodegradable Glucose-Containing Naturally Abundant Deep Eutectic Solvent (NADES): Temperature Dependent Time-Resolved Fluorescence measurements*" by Ejaj Tarif, Jayanta Mondal, and **Ranjit Biswas**, *Journal of Physical Chemistry B* **2019**, *123*, 9378-9387.

2. "*How frictional response during solute solvation controls solute rotation in naturally abundant deep eutectic solvent (NADES)? A case study with amino acid derivative containing DES*" by E. Tarif, J. Mondal and R. Biswas" by Ejaj Tarif, Jayanta Mondal, and **Ranjit Biswas**, *Journal of Molecular Liquids*, **2020**, 303, 112451(1-11).