Women, Forty Years on Inverse Gas Chromatography: New Methods and models for the Characterization of Surfaces and interfaces of Materials

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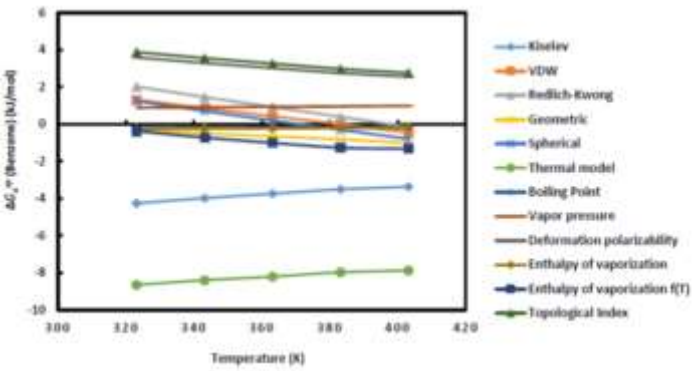
Abstract

The inverse gas chromatography (IGC) technique at infinite dilution was used during the last forty years to determine the surface physicochemical properties, the Lewis acid-base constants as well as the London dispersive surface free energy γ_s^d of materials and nanomaterials. In this study, we give a new and complete methodology to study the surfaces and interfaces of materials by criticizing the classic chromatographic models and by proposing new models that give more accurate results.

While the London dispersive surface free energy was estimated by using the well-known Fowkes equation, Dorris-Gray relation, we proposed a correction to this relation and testing six other molecular models based on the values of the surface areas of organic molecules and Hamieh model taking into account the thermal effect.

We determined new expressions of the various surface area, respectively, of n-alkanes $a(n,T)$, methylene group a_{-CH2-} and polar molecules $a_X(T)$ versus the temperature T and using the new expressions to obtain more precise values of the surface parameters of materials. The Gibbs surface free energy of the adsorption values obtained by inverse gas chromatography against the temperature was determined for many surfaces by using fourteen methods such as that of Swayer-Brookman, Saint-Flour Papirer, Donnet, Brendlé and Papirer, Chehimi et al, Hamieh methods (thermal method and the methods of the enthalpy of vaporization as a function of the temperature $\Delta H_{vap}^0(T)$ and the standard enthalpy of formation ΔH_f^0 and the six molecular models. The Lewis acidity parameter K_A and Lewis basicity parameter, K_D was calculated by the above stated fourteen methods. Our results based on the new concepts and models gave the more accurate values of the specific surface thermodynamic variables of materials compared to the other inverse gas chromatography methods.

Image



Variations of ΔG_a^{sp} as a function of the temperature for benzene adsorbed on silica particles by using the different IGC models and methods: Kiselev, Van der Waals, Redlich-Kwong, geometric, spherical and thermal models of molecular surface areas; and Boiling point, vapor pressure, deformation polarizability, enthalpy of vaporization, $\Delta H_{vap.}^0$, $\Delta H_{vap.}^0(T)$ and Topological index methods.

Recent Publications (minimum 5)

1. New methodology to study the dispersive component of the surface energy and acid–base properties of silica particles by inverse gas chromatography at infinite dilution, Journal of Chromatographic Science 60 (2), 2022, 126-142,
2. T Hamieh, A Ali-Ahmad, A Jrad, T Roques-Carmes, M Hmadeh, J Toufaily, Surface thermodynamics and Lewis Acid-Base Properties of metal-organic framework Crystals by Inverse Gas Chromatography at infinite dilution, Journal of Chromatography A, 1666, 2022, 462849
3. BP Kumar, PV Rao, T Hamieh, CW Kim, Comparative study of nitrogen doped multi walled carbon nanotubes grafted with carboxy methyl cellulose hybrid composite by inverse gas chromatography and its UV photo detectors application, Journal of Chromatography A 1670, 2022, 462997.
4. T Hamieh, AA Ahmad, T Roques-Carmes, J Toufaily, New approach to determine the surface and interface thermodynamic properties of H-β-zeolite/rhodium catalysts by inverse gas chromatography at infinite dilution, Scientific Reports, 2020, 10 (1), 1-27.
5. Praveen Kumar Basivi, Visweswara Rao Pasupuleti, Tayssir Hamieh, Surface thermodynamic properties of Sodium Carboxymethyl Cellulose by Inverse Gas Chromatography. 2021, Chemical Engineering Journal Advances, 9, 100207.
6. Hamieh T., *Study of the temperature effect on the acid-base properties of cellulose acrylate by inverse gas chromatography at infinite dilution*, *J. Chromatogr. A.* 1568 (2018) 168-176.

Biography

Hamieh T completed his first PhD in Physical Chemistry (1985), his HDR (1996) and obtained in 2001 his second Ph.D. in Mathematics from the UHA, France. He is now Adjunct Professor at Maastricht University. He was Professor at Lebanese University. He was invited researcher at University Gustave Eiffel. He was Professor at UHA until 2002, invited professor (1998) at University of Alberta, Canada, Visiting Professor (2003 and 2017) at the University of Poitiers. He published over 250 international publications that have been cited over 3700 times and he has been serving as an editorial board member and reviewer of reputed Journals. He supervised and co-supervised more than 30 PHD and 60 master theses. He also served on many academic, administrative responsibilities, chairperson and editor of many conferences on Materials Sciences; His skills and expertise cover large domain of physical chemistry of materials and nanomaterials, surfaces and interfaces.

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Notes/Comments:

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