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Glass-crystalline membrane materials for helium and hydrogen capture based on fly ash cenospheres – a new trend in the utilization of coal power plant waste

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The multi-component composition of coal power plant fly ashes is a serious limitation in their bulk utilization. Cenospheres, are one of the microspherical components of fly ash, which are potentially suitable for the development of materials for different purposes. In recent years, new functional materials were developed based on a detailed characterization of narrow fractions of cenospheres with specific composition and structure. Among these materials are highly selective microspherical membrane materials for the production of high-purity helium and hydrogen, highly effective composite sorbents for long-term isolation of radionuclides in mineral-like forms, magnetically controlled encapsulated pH-sensitive spin probes for the examination of biological objects, and sensitizers of emulsion explosives capable of replacing hollow synthetic microspheres. One of the promising directions is using cenospheres as highly selective membrane materials for the production of high-purity helium and containers for storage and transportation of hydrogen. It was established that the permeability coefficients for the glass phase of cenosphere shells from different fly ashes are directly proportional to the content of the glass-forming oxide SiO_2 in it. The experimental values of the permeability coefficients significantly exceed those for homogeneous silicate glasses for helium and hydrogen by a factor of 3–24 and 12–111, respectively. This fact can be explained by an essential difference between the states of two types of glass phases formed under substantially different conditions. The homogeneous glasses are formed under long-term annealing conditions at a constant temperature. Thin shells of the cenospheres have a fragmentary structure which was formed as a result of the coalescence of molten micro-droplets (1.0–2.5 μm) of an aluminosilicate precursor under conditions of high temperature gradients. The glass phase of the cenospheres thus formed differs significantly from the homogeneous glass phase, primarily, by the free-space geometry, which has a critical influence on the process of gas diffusion.

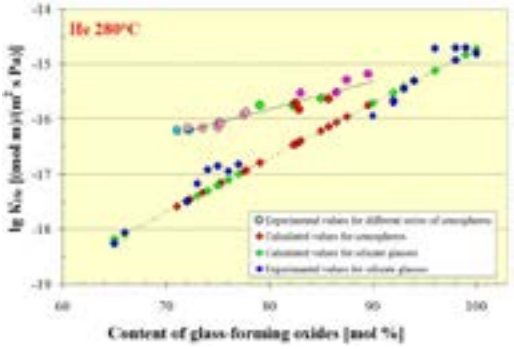

Figure 1: Dependences of the helium permeability coefficients (experimental and calculated values) for the glass phase of cenosphere shells on the content of glass-forming oxides in comparison with the data for silicate glasses of different compositions

Biography

El Assal F M is Professor of Invertebrate Zoology at the Department of Zoology, Faculty of Science, Cairo University, since 1993. He is interested in the conservation of the freshwater ecosystem with regards to pollution, and biological control of snail vectors of parasitic diseases. He published more than 50 papers and planned and supervised more than 60 MSc and PhD thesis at the Cairo University.

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