
The bond valence method applied to glass structure

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Abstract

Glasses have a structure in which the atoms connect together to form a network that has a random nature. Nevertheless, the short range order in a glass (the bond lengths, coordination numbers and coordination polyhedra) can be as well defined as in an ordered crystal structure. The random nature of the glass structure then arises from variability in the way that the basic structural units connect together. For an understanding of the bonding and structure in a glass it is thus essential to understand in detail the structural units and the connections between them.

The bond valence method has arisen from detailed study of the structure of crystalline materials, and it provides a way of understanding the bond lengths and coordinations that occur between atoms in solids. The application of the method to glass structures will be discussed [1], with examples that include germanate, tellurite and phosphate glasses. Of particular value is the distortion theorem [2], which can be applied to understand the behaviour of the bond lengths in an oxygen bridge in an oxide glass. For example, germanate glasses show a behaviour of the mean Ge-O bond length that is apparently anomalous, in that it is significantly longer for high modifier glasses than for low modifier glasses, even though the structures of both are based mostly on GeO₄ tetrahedra [3]. It will be shown how this behaviour can be understood by application of the bond valence method. The method can also be applied to tellurite glasses, for which the oxygen bridges can be highly asymmetric, and to phosphate glasses which have the unusual feature of terminal oxygens.

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Keywords: structure, bonding, coordination number, bond length, germanate, tellurite, phosphate

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