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AMORPHOUS MATERIALS: PROPERTIES, STRUCTURE, AND DURABILITY†

Constrained interactions, rigidity, adaptative networks, and their role for the description of silicates

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ABSTRACT

Silicate glasses can be seen as connectivity networks where specific tools are used for the understanding of the behavior with composition of their chemical and physical properties. These tools make use of the effective interatomic interactions and mechanical constraints such as those used for analyzing the stability of macroscopic trusses. We first describe how complex interactions and coordination numbers can be efficiently handled within a general framework. The ingredients of the general framework, also known as mean-field bond constraint theory, are then presented. The theory predicts flexible to stressed-rigid elastic phase transitions at threshold compositions (or mean-coordination numbers). Applications to alkali- and alkaline-earth-silicates are considered and experimental signatures of the phase transition identified. Finally, we focus on the latest development in the field, namely the appearance of a new self-organized intermediate phase between flexible and stressed-rigid phases. Experimental signatures of these phases are reviewed, and the tools of adaptative silicate networks used to understand their features.

Keywords: Network glasses, silicates, rigidity, constraints