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**Preparation of ultra-small molecule-like Ag nano-clusters in silicate glass based on ion-exchange process: energy transfer investigation from molecule-like Ag nano-clusters to  $\text{Eu}^{3+}$  ions**

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**Abstract:** Ultra-small silver nano-clusters are a novel kind of materials with excellent photoluminescence properties, which have potential application in the fields of integrated optical storage, biological optics sensor and solid state lighting. In this work, ultra-small molecule-like Ag nano-clusters were prepared in the silicate glass by the ion-exchange process. The influence of ion-exchange temperature, ion-exchange time and ratio of molten salt composition on the formation of molecule-like Ag nano-clusters was investigated systematically in the silicate glass by the transmission electron microscopy, optical absorption and photoluminescence spectroscopy. The results demonstrated that the stabilized molecule-like Ag nano-clusters with the size of 1-3 nm were formed by controlling the ion-exchange parameters. In addition, the influence of  $\text{Eu}^{3+}$  doping on the formation of molecule-like Ag nano-clusters was observed in the silicate glass, promoting the growth of molecule-like Ag nano-clusters. The luminescence enhancement of  $\text{Eu}^{3+}$  was obtained due to efficient energy transfer from molecule-like Ag nano-clusters to  $\text{Eu}^{3+}$ .

**Keywords:** Photoluminescence; energy transfer; molecule-like Ag nano-clusters; ion-exchange

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