Post-melting encapsulation for the development of advanced composite glasses

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Inorganic oxide glasses offer an outstanding platform for the development of transparent materials, architectures, and coatings with unique optoelectronic, optical, and photonic features. A recent approach in this field towards advancing applications potential consists of the incorporation of functional materials like perovskite nanocrystals (PNCs), two-dimensional (2D) materials, and metallic nanoparticles, within various types of glass matrices [1]. However, there are several limitations on the fabrication routes regarding the feasible growth of these materials within inorganic oxide glasses. The main one emerges from the necessity of typical high temperature melting protocols, in some cases exceeding 800 ^{o}C, that are required for most glasses [1]. The high temperature melting procedure is cost ineffective for large scale production, while it causes concerns for the stability of the incorporated functional materials. To tackle this scientific challenge, recently in our lab, we have developed a post-glass melting low temperature fabrication procedure that allows the controllable encapsulation of functional materials within glasses, i.e. after the initial glass melting (Figure 1a) [1]. Based on this simplified approach the controllable incorporation of PNCs [2], 2D materials [3], and nanoparticles [4], within transparent phosphate glasses is achieved at the moderate temperature of 160 ^{o}C. The perspectives of our fabrication route will be presented towards the realization of stable composite glasses with superior optical and luminescence properties for optoelectronic applications. In particular, the developed perovskite glasses (PV-Glasses) exhibit remarkable photoluminescence (PL) stability since the glass matrix offers great moisture protection to the PNCs, while simple continuous wave laser processing allows the formation of highly luminescent periodic micro-patterns inside the glass (Figure 1b) [2]. In case of 2D materials composite glasses (2D-Glasses), the post-glass melting encapsulation approach allows the enhancement of room temperature PL properties upon inducing B-exciton emission in few-layers of embedded MoS_2 (Figure 1c) [3].

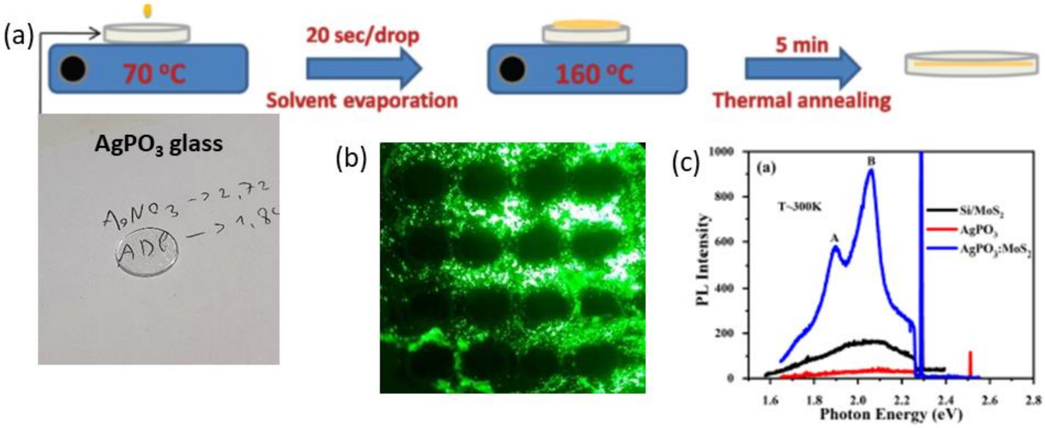

Figure 1: (a) Schematic representation of the post-glass melting encapsulation procedure. (b) Fluorescence photo of an encapsulated PNCs micro-dotted optical pattern. (c) Room temperature photoluminescence (PL) of MoS_2:$AgPO_3$ nanoheterojunction.

References

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