New functional materials for a wide range of applications (chemistry, biology and electronics) multiplied in the last 20 years. Active lightning and/or chromic devices are important part of daily life (e.g., LEDs), but frequently require organic compounds prone to degradation processes, toxic elements or expensive raw materials such as rare earths, indium, ruthenium or iridium. The use of common and inexpensive raw materials is key for future sustainability and development of devices such as solar cells, LEDs, chromic devices, etc, as e.g. rare-earths availability is predicted to be insufficient in the next 20 years [1]. This is a significant challenge when combined with the necessary performance improvement: higher durability, energy efficiency and inexpensive production. Inorganic materials such as glass have intrinsically high durability and are synthesized from widely available resources such as silicates. Photoluminescent glass is easily achieved by doping with rare earths such as europium [2]. Luminescent Solar Concentrators (LSC) appear as an application, by converting solar light to visible light tailored in order to improve the efficiency of Solar Cells.[3] Stable and nonexpensive aluminoborosilicate glasses with different photoluminescence colours were synthesized by doping with Pb(II) and sodium halides. Glasses doped with NaBr and NaI display room-temperature photoluminescence at 435 and 530 nm, respectively, attributed to nanocrystals whose presence is revealed by transmission electron microscopy.[4,5] Recently this study was extended to non-toxic Sn(II) doped photoluminescence glasses, where Cu(I) can also be easily introduced to achieve tuning of the performance of the glasses due to their high Stokes shifts and emission spectra in the orange/red region. Relative compositions of Sn(II) and Cu(I) can give rise to glasses which exhibit white photoluminescence. This strategy allowed the synthesis of aluminoborosilicate glasses with quantum efficiencies up to 50%, with excellent optical properties for application in photovoltaics. Furthermore inclusion of halides will be discussed, specially their role in the stabilization of Sn(II) and Cu(I) oxidation states on the glass matrix.

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References:
César A.T. Laia has a PhD thesis in Chemical Engineering at Instituto Superior Técnico, Portugal, specialized in Photochemistry and Colloidal Chemistry. With a strong background in photochemical processes, at LAQV-REQUIMTE his research interests are focused on chromogenic (photochromism, thermochromism and electrochromism) or luminescent materials. In collaboration with Ynvisible company, applied research in electrochromism is ongoing and from this collaboration several scientific papers and patents were published. These electrochromic systems are both organic (by using semiconductor polymers) or inorganic (using metal oxides), showing large color contrasts between on/off states, fast switching times and very high durability. A collaboration with VICARTE, as leaded to development of photochromic/photoluminescent inorganic glasses and/or pigments. The main advantage of inorganic photochromic pigments is their resistance to photo-oxidative degradation, and therefore it is a major challenge to develop this type of materials. Currently research using silver halides and sulfur clusters in glass or zeolite matrixes is being carried out. The development of intrinsically luminescent ionic liquids is also a research interest, mainly due to their promising applications across several areas (e.g., oLEDs, glass surface cleaning).

5 selected publications:


