Defect-related photo and electronic properties of silica, magnesia, and alumina

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Oxides of third period elements such as silica (SiO_2), magnesia (MgO), and alumina (Al_2O_3) are often referred to as refractory oxides because of their high melting temperatures and hence have been used as physically and chemically inert materials, e.g., substrates for GaN-based devices, optical fibers, and gate insulators. It should be noted, however, that oxides of third period elements themselves cannot normally be regarded as functional materials because they hardly interact with external electric and magnetic fields. Even when incorporated in functional materials, these oxides are expected to behave as a stable matrix containing various activator ions. One example is a Ti:sapphire laser rod, in which sapphire (α-alumina) is used as an excellent laser host with high optical transparency and good thermal conductivity.

In our recent publications, however, we have demonstrated that these refractive oxides can exhibit efficient ultraviolet/visible emissions by carefully controlling their microscopic structure and stoichiometry without adding any activator metals. Some intriguing properties, such as blue light emission [1], random lasing [2], photoinduced reversible interconversion of color centers [3], have been achieved. The present approach will open up new routes and strategic issues to produce highly functionalized materials consisting solely of third period elements. The present approach can also be applied to multi component oxide systems, including spinel ($MgAl_2O_4$) and forsterite (Mg_2SiO_4).

References

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