Public Abstract
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Title:Patterning of Silicalite-1 Films Using CO2 Laser Ablation and Impact on their Optical Characteristics

Although the field of integrated optics has advanced tremendously, the state-of-the-art still lags behind its electronic counterpart. One of the main challenges that consistently arises is the creation, characterization, and evaluation of new material systems for this field. For instance, nanostructured materials, like carbon nanotubes, graphene, quantum dots, and a plethora of oxide-based materials have properties that could be beneficial to integrated optics; however, very few of these materials have been evaluated for this purpose. This limits their use in integrated optical systems. Porous, nanostructured oxide materials, like zeolites, have unique and complex relationships between structure and physicochemical properties that can be tuned during their synthesis by interchanging framework atoms such as Zn, Ti, etc. or by introducing guest molecules, such as small organic molecules or nanoparticles. In particular, zeolites have uniform microporosity and structural symmetry, and can be produced in a variety of topologies that result in desirable physicochemical properties, such as high surface area, thermal stability, and shape and size selectivity, in addition to unique optoelectronic properties tailored by guest/host interactions. Using the same model zeolite system and composition (topology MFI), in thin film form we evaluate its potential for integrated optics.

The synthesis and patterning of nanostructured materials in a controlled fashion is of great interest for application in electronic devices, photonics, energy storage, and biological/chemical analysis. Recently, porous, nanostructured materials, such as silicalite-1 zeolite films, have been used to form 2D and 3D structures for building nano-containers and other intricate assemblies for harvesting light, for sensing applications or for creating microreactors. Traditionally, these films have been synthesized as multilayers of randomly oriented crystals; however, these types of new applications require precise control of the crystal orientation, surface coverage, film thickness and, most importantly, post-synthetic patterning. The standard methods used to pattern such nanostructured materials are based on either typical microfabrication techniques, which involve several complex steps of long duration, or organization of pre-formed seeds/crystals arranged uniformly by chemical linkages, which requires precise control and positioning and could result in pore clogging. To avoid these challenges, we evaluate the use of CO2 laser ablation, which has earlier shown good potential for patterning of sol-gel materials. Here, we demonstrate the effects of this technique on the patterning of a model zeolite thin film system, silicalite-1 (MFI), to evaluate its potential for patterning complex, multicrystalline, nanostructured materials.

The effects of CO2 laser irradiation on silicalite- films i.e. densification effects to cause changes in degree of porosity, crystallinity which in turn results in changes in transmission and absorption characteristics of the films (IR and Raman spectrum) and the evolution these properties on account of changes in laser irradiation power were also studied. The results of this study will help determine the suitability of zeolites for optoelectronic materials and introduces a one-step, non-destructive and rapid technique to pattern materials with specific framework structures and subnanometer pore sizes thus broadening their usage in areas of optical sensing, optical signal processing or optical computing.