

EMERGING TRENDS ON NOVEL MESOPOROUS ALUMINOPHOSPHATE FOR ENVIRONMENTAL APPLICATIONS

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ABSTRACT:

Porous materials are becoming more popular in a variety of high-impact applications due to their lightweight structure, mechanical durability, and biomimetic properties (aerospace, automotive, and biomedical). Recent advances in sophisticated material design, development, and characterization techniques have preserved methodologies for tailoring features based on application-specific properties. Porous materials can be used in a variety of ways. Synthetic zeolites and related porous materials are ordered microporous solids that have been economically employed in large quantities. Mesoporous materials have long been recognized, but their applications have been limited due to pore size heterogeneity and uneven arrangements.

Keywords: Novel, Mesoporus, Aluminophosphate, Environment.

INTRODUCTION:

A literature review is a summary of what has been published on a given topic by reputable academics and researchers. A literature review is a search and assessment of the existing literature in a subject or topic area. It establishes the current state of knowledge in the field of the issue or topic you're writing about.

The many uses of mesoporous aluminophosphate molecular sieves, synthetic procedures, and organic dye removal methods using various materials as adsorbents were the focus of this literature study.

CRITICAL REVIEW: A GLIMPSE:

Subrahmanyam et al. [1] investigated the catalytic activity of mesoporous trivalent iron substituted aluminophosphate for the oxidation of cyclohexane.

Subrahmanyam et al. [2] use a vanadium-based mesoporous aluminophosphate material as a catalyst.

Jinghui Shi et al. [3] investigated the catalytic activity of mesoporous aluminophosphate in the synthesis of ethyl methyl carbonate.

Martin Hartmann et al. [4] explore the catalytic activity of new mesoporous Nb-AlPO₄ materials for the oxidation of cyclohexane.

Kimura et al. [5] investigate the production and application of thermally stable (600 °C)

mesoporous AlPO₄ materials.

Limin Wang et al.[6] investigated the fabrication of large pore (12 nm) mesoporous aluminophosphate materials utilising the templating approach.

Swapan K das et al.[7] explored the use of mesoporous aluminophosphate for the removal of heavy metal cations from contaminated water.

Ma et al. [8] investigated the usage of mesoporous aluminophosphate as an adsorbent for the removal of metal cations.

Yaroslav et al. [9] examine the synthesis and characterisation of mesoporous boron aluminophosphates.

Shaobin Wang et al. [10] investigated the adsorptive removal of a methylene blue from an aqueous solution using fly ash and red mud.

Yasemin Bulut et al. [11] utilised wheat shells to remove methylene blue from aqueous solutions.

Chih-Huang Weng et al. [12] explore the adsorption kinetics mechanism of methylene blue on sludge ash.

Alok Mittal [13] uses hen feathers as a possible adsorbent to remove a dangerous triphenylmethane colouring, malachite green, from waste water.

Xubiao Yu et al. [14] examine the development of an organovermiculite-based adsorbent for extracting anionic dye from aqueous solution.

Bhuvaneswari et al. [15] explore the adsorptive removal of dyes on plant roots and green carbon.

M. C. Ncibi et al. [16] investigated the removal of textile reactive dye using *Posidonia oceanica* (L.) fibrous biomass through adsorption.

T.A. Albanis et al. [17] examine dye removal through adsorption utilising fly ash and soil mixture in batch and column procedures.

Safarik et al. [18] employ magnetically labelled Baker's yeast cells to remove dyes through adsorption.

C.C.Chen et al. [19] investigated the decolorization of Victoria blue R dye and its mechanism utilising *Acinetobacter calcoaceticus* YC210.

Ahmed Al-Futaisi et al. [20] investigated the adsorption of cationic dyes, methylene blue, and crystal violet from aqueous solutions on palygorskite clay.

Tahir et al. [21] investigated the ability of bentonite to remove malachite green from aqueous solutions.

Nandi et al. [22] investigated the adsorption of hazardous cationic dyes, crystal violet, and brilliant green from aqueous medium using commercially available kaolin.

Paula V. Messina et al. [23] explore the adsorptive removal of methylene blue (MB) and

rhodamine B (RhB) from aqueous solution onto mesoporous silica-titania composites.

Yupeng Guo et al. investigated the adsorption of malachite green (MG) from aqueous medium using rice husk-based porous carbons (RHCs). [24,25]

Vasanth Kumar et al. investigated the adsorption of malachite green onto lemon peel and methylene blue on activated carbon. [26, 27]

Ponnusami et al.[28] investigated batch adsorption studies employing a new adsorbent, guava leaf powder (GLP), for the removal of methylene blue (MB) from aqueous solutions.

Rita Dhodapkar et al. [29] studied the elimination of basic dyes safranin T, methylene blue, crystal violet, light green, brilliant milling violet, and patent blue VS from aqueous solutions utilising biodegradable polymeric absorbent materials.

Oualid Hamdaoui [30] investigates the adsorption of the basic dye methylene blue from aqueous solution on cedar saw dust and broken brick.

Kannan et al. [31] explore the traditional adsorbents used for azo dye adsorption, such as activated carbon, agricultural wastes, molecular sieves, and so on.

EMERGING TRENDS AND NOTEWORTHY CONTRIBUTION:

Lü JM et al. (2005) stated that a nonionic surfactant tri-block copolymer (PEO20PPO70PEO20) was used as the structure-directing agent to produce mesoporous aluminophosphate materials with varying quantities of zirconium at room temperature. Powder X-ray diffraction of AlPO and ZrAlPO mesoporous materials as produced and calcined reveals a single broad peak near $2\theta = 2.5^\circ$, indicating the average pore-pore correlation distance. The ratio of P/Al in the powders is 0.5, significantly lower than the 1.0 required for a perfect aluminophosphate framework, according to electron probe microanalysis. The calcined samples are wormlike tubular materials with surface areas >350 m²/g and pores in the mesopore region, according to XRD, TEM, and N₂ adsorption data. Electron spin resonance (ESR) examinations of γ -irradiated and evacuated ZrAlPO samples reveal Zr³⁺ signals that increase with Zr concentration, as well as signals from framework defects (V centres) and H atoms. The Zr³⁺ line shape and g values are best explained by the presence of a trivalent zirconium ion at the framework tetrahedral sites.[32]

Conesa TD et al. (2006) stated that the synthesis of these silicoaluminophosphates included the use of gel mixes including amorphous mesoporous aluminosilicate and aluminophosphate phases as precursor.[33]

Martins AC, Fernandez-Felisbino R, Ruotolo LAM (2012) stated that heavy metals can be found in aqueous effluents from a range of industrial activities. Given the toxicity of metal-polluted wastewaters, ion exchange looks to be a simple and cost-effective method of removing metal ions. There is a lot of research going on right now into synthetic and natural materials that could be used as cation exchangers. Because of their high surface area, porous diameter, and ion exchange capacity, microporous molecular sieves have been proposed as one of these materials. The ionothermal approach was used to make aluminophosphates (AlPOs) utilising the eutectic mixture urea/choline chloride (CCh) as the solvent and template. The eutectic mixture employed in gel production had varied CCh ratios, which led in diverse structures with highly varying ion exchange capabilities. SIZ-2 and AlPO-CJ2

were the main structures discovered. When the amount of CCh in the gel synthesis mixture was varied, it was discovered that CCh percentages larger than 50% produced the AlPO-CJ2 structure, whereas 25% and 33.3 percent CCh produced SIZ-2. The ammonium cations produced by the partial breakdown of urea are the structure-directing the interrupted structure. The ion exchange capacity of the SIZ-2 prepared with 25% CCh is slightly larger than that of the SIZ-2 prepared with 33.3 percent CCh. Because CCh is the most expensive component in the eutectic combination, this conclusion is quite intriguing.[34]

Tao S et al. (2015) stated that using both conventional and microwave heating, extra-large-pore aluminophosphate –CLO (i.e. DNL-1) nanocrystals were produced in a eutectic mixture of diethylamine hydrochloride (DEAC) and ethylene glycol (EG) with 1-methylimidazole (1-MIm) as an additional amine. The impact of synthesis parameters on the creation of DNL-1 nanocrystals, such as the amount of 1-MIm and the P/Al ratio, were investigated. A number of methodologies were used to characterise the products. The as-synthesized DNL-1 nanocrystals exhibit good crystallinity and narrow particle size distributions, according to XRD, DLS, SEM, and TEM findings, and their average particle size was regulated in the 100–220 nm range by simply increasing the amount of 1-MIm. The as-synthesized DNL-1 nanocrystals have good thermal stability, and the calcined samples have high BET surface areas and large pore volumes, according to TG–DSC and N₂ adsorption studies. In the creation of DNL-1 nanocrystals, the cooperative structure-directing actions of 1-MIm and the eutectic mixed cation (DEA⁺) were also discussed.[35]

Wang YS et al. (2018) stated that phosphate activation can turn an aluminosilicate precursor, such as metakaolin, into a cement-like geopolymer binder. The influence of adding aluminium species to the phosphate activating solution on the production of such geopolymers, from the fresh to the hardened stage, is investigated in this article. By combining monoaluminum phosphate (MAP) and orthophosphoric acid, activating solutions with Al/P molar ratios of 0, 0.1, and 0.3 were created (OPA). The compressive strength of hardened geopolymer matrices and the rheological characteristics, fluidity, and setting periods of fresh geopolymer pastes were investigated. Spectroscopic, thermal, and microscopic analyses, as well as liquid-state ²⁷Al and ³¹P nuclear magnetic resonance (NMR) measurements for the chemical environments of Al and P, revealed that soluble aluminium in the phosphate activating solution played an important role during the geopolymerization process. The presence of aluminium species in the activating solution resulted in a quick sol/gel transition, which improved the rheological characteristics and setting time of fresh geopolymer pastes at room temperature. However, while the soluble aluminium addition promoted an increased concentration of aluminium phosphate oligomers, which resulted in the formation of a compact matrix with high early strength, it hampered the ongoing reaction of metakaolin in the later period, which has a negative impact on ongoing strength development beyond 7 days of curing.[36]

Bhanja P et al (2019) stated that the use of metal phosphate and phosphonate-based nanoarchitected materials allows for the creation of hierarchically porous nanomaterials with interconnected micropores, mesopores, and macropores. The phosphate and phosphonate moieties operate as ligand sites/linkers to generate a wide range of nanoarchitected materials due to their great affinity for metal centres. The synthetic routes for creating essential microporous and mesoporous phosphate and phosphonate molecular sieves have been summarised in this article. Future research will focus on developing novel nanoarchitectures of metal phosphate and phosphonate-based microporous and mesoporous materials for catalysis, adsorption, optoelectronics, electrochemical cells, fuel cells, and

medicinal applications.[37]

CONCLUSION:

The above literature review revealed that a number of works have been done in the field of preparation of porous aluminophosphate molecular sieves by various materials as structure directing agents. In this research work, it is planned to synthesise mesoporous aluminophosphate based molecular sieves by using lauric and myristic triglycerides as structure directing agents to control the pore size of the material. The aluminophosphate based materials are applied for the removal of organic dyes from aqueous solutions.

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