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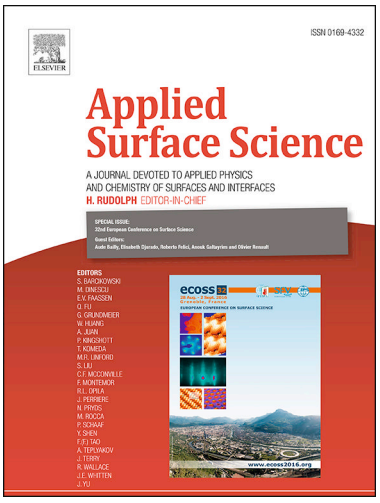


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# Swift sono-hydrothermal synthesis of pure NaX nanocrystals with improved sorption capacity from industrial resources

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**Abstract**

Synthesis of nanocrystalline zeolite with high purity from industrial resources like fly ash is extremely challenging and it takes days to synthesize even macro-size zeolite with high purity and realistic sorption capacity under conventional alkaline activation method. In present work, sono-hydrothermal method has been found to be really rapid and yielded high pure NaX nanocrystals with high sorption capacity in 20 minutes of ultrasonic irradiation from differently sources fly ashes with Si/Al ration less than 3. Average crystal size of X type nanozeolite ranges between 19-27 nm. and sorption properties towards different metal ions such as $Zn^{2+}$, $Cu^{2+}$, $Cd^{2+}$, $Pb^{2+}$, $Ni^{2+}$, $Ca^{2+}$, and $Mg^{2+}$ as well as various organic dyes such as methylene blue, crystal violet, indigo carmine, and congo red was evaluated. All the nanocrystalline zeolites X were found to be superior to other low cost adsorbents including the commercially available zeolite X towards various metal ions and dyes. Highest adsorption capacities were found for the $Pb^{2+}$ and crystal violet among all metal ions and dyes (a maximum of 171.23 mg $g^{-1}$ for $Pb^{2+}$ and 149.36 mg $g^{-1}$ for crystal violet).

**Keywords:** Nanocrystalline NaX; coal fly ash; sono-hydrothermal; adsorption; heavy metals; dyes.

## 1. Introduction

Zeolites are crystalline hydrated aluminosilicates with highly porous 3D framework which contains different cage and cavity structures, resulting in unique sorption behaviour. Zeolites are highly stable and eco-friendly and are widely employed at various fields as catalyst [1], ion exchange material [2,3], and adsorbent [4–6]. Plentiful of work have been done for several decades on alkaline activation of aluminosilicates which resulted in zeolites of different category and physicochemical properties. Exploring industrial aluminosilicates resources such as coal fly ash gives rise to a cheap method of getting this unique porous material even though it has been a challenging task to get a highly pure zeolite with desirable properties for wide real time applications. Recently, researchers have been paying attention to synthesis of nano-zeolites having a dimensions of <100 nm with better characteristics such as high surface area, greater active sites and narrower diffusion pathways than micro- and macro-sized zeolite particles [7,8]. Synthesis of nanoscale zeolites from industrial waste resources has been a challenging task even though a few researchers have attempted synthesizing nanozeolites like ZSM-5 [9], NaX [10,11, 12], NaA [13,14], it took days to get zeolites with high purity and desirable properties.

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