

PAPER • OPEN ACCESS

## Quicklime as an alternative in the photodegradation of contaminants

To cite this article: M R Joya *et al* 2016 *J. Phys.: Conf. Ser.* **687** 012044

View the [article online](#) for updates and enhancements.

### You may also like

- [Optimization of non-autoclaved aerated concrete using phosphogypsum of industrial waste based on the taguchi method](#)  
Ndaru Candra Sukmana, Mohammad Izzudin Khidillah, Avan Sugeng Nurkholil et al.
- [Influence of Composition of Technogenic Materials-sourced Aluminosilicate Binder onto Structural Formation and Performance Properties of Construction Composites](#)  
A A Volodchenko, V S Lesovik and A N Volodchenko
- [Effect and Mechanism of Quicklime on Stabilized Loess](#)  
Xie Xiao, Yulu Wei and Gao Wang



The Electrochemical Society  
Advancing solid state & electrochemical science & technology

## 241st ECS Meeting

May 29 – June 2, 2022 Vancouver • BC • Canada

Abstract submission deadline: Dec 3, 2021

Connect. Engage. Champion. Empower. Accelerate.  
**We move science forward**



**Submit your abstract**



# Quicklime as an alternative in the photodegradation of contaminants

M R Joya<sup>1</sup>, J H Bautista Ruiz<sup>2</sup> and A M Raba<sup>2</sup>

<sup>1</sup> Universidad Nacional de Colombia, Bogotá, Colombia.

<sup>2</sup> Universidad Francisco de Paula Santander, San José de Cúcuta, Colombia.

E-mail: mrinconj@unal.edu.co

**Abstract.** Chemical oxidation is one of the many different methods of removing contaminants that has emerged recently, is an alternative method to traditional techniques. According to this research calcium peroxide is suitable choice for contaminant biodegradation in soil and ground water, but it happens at a very low speed. We hope that the method of synthesis of calcium peroxide in nano size by increased ratio of surface to volume can increase the speed of reaction and solve the problem. In the first synthesis of the material we obtained  $CaO$  instead of  $CaO_2$ . Calcium oxide ( $CaO$ ), commonly known as quicklime or burnt lime, is a widely used chemical compound in obtaining hypochlorite and to neutralize acidic soils. In this study we characterize the material by X-ray scanning electron microscopy, and ultraviolet-visible spectroscopy.

## 1. Introduction

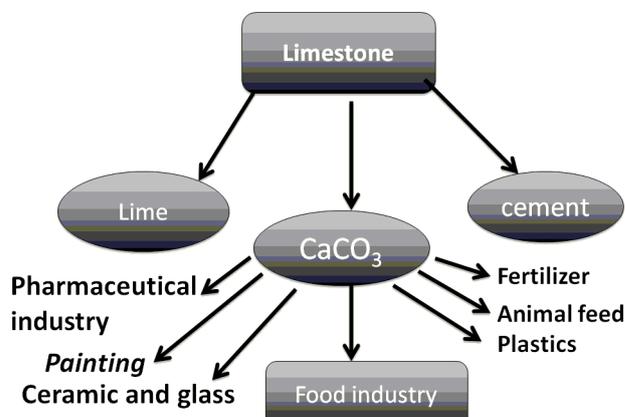
$CaO$ -based sorption material is most abundantly available from natural resource such as limestone and dolomite. The sources of  $CaO$  are not limited to these two sources only. There are other researchers that proposed to use biomaterial sources such as from crab shell and oyster shell as the source of  $CaO$  [1]. Calcium oxide ( $CaO$ ) is an important inorganic compound, which is used across various industries as catalyst, toxic-waste remediation agent, adsorbent, etc [2].

Among the heterogeneous catalysts that are being used in transesterification, calcium oxide ( $CaO$ ) has a promising place, and many reports have been published on  $CaO$ -catalyzed transesterification using laboratory grade. It is cheap, abundantly available in nature (as limestone), and some of the sources of this compound are renewable (waste material consisting of calcium carbonate,  $CaCO_3$ ). However, the utilization of waste materials as heterogeneous catalysts has been of recent interest in the search for a sustainable process [3, 4].

Calcium Oxide is a off white coloured bulky powder. It is also called lime, quicklime or caustic lime. Calcium oxide is highly reactive with moisture or water. It releases considerable heat when it gets hydrated. As it can react with the moisture in the air as well, it is often used as a desiccant. The reaction takes place with carbon dioxide generating water insoluble carbonates. Due to this property of Calcium Oxide, it is used in plastic industry as well for the removal of moisture. Besides this, other uses of calcium oxide include manufacturing porcelain, glass, bleaching powder, calcium carbide, calcium cyanamide and purifying sugar. It is used in water softeners and also in mortar and cement. It is also used to treat acidic soil [5], in Figure 1, some applications are observed in the limestone. Calcium Oxide is used in metallurgy industry with different purposes. In Steel is incorporated during iron and steel process as clinker agent,



for then be able to eliminate impurities existing in metal parts. Calcium Oxide (lime) must contain of a high purity to improve its reactivity and performance [6].



**Figure 1.** The processing and major uses of limestone [7].

## 2. Theoretical Formalism

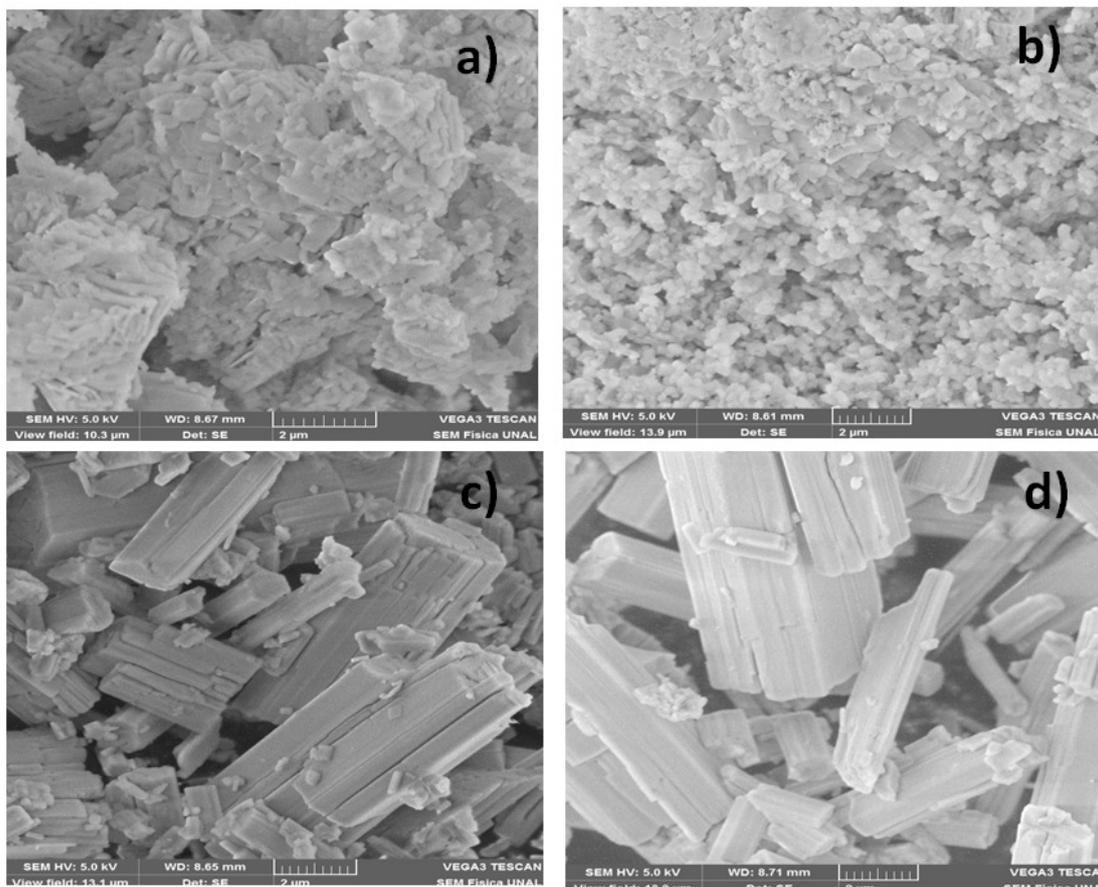
Calcium oxide powders were prepared from polymeric precursors by the Pechini method [8]. The metal calcium Sulphate 2-hydrate solution was mixed with a stoichiometric amount of citric acid. The resulting solution was stirred for about 1 hour on a hot plate and the temperature was stabilized at  $70^{\circ}\text{C}$ . The mixture was heated to  $90^{\circ}\text{C}$ , at which point ethylene glycol was added at a mass ratio of with respect to citric acid. The temperature was maintained constant up to resin formation, which polymerized at  $300^{\circ}\text{C}$ . The precursor powders were then calcined for 2 hours at various temperatures, ranging from  $350^{\circ}\text{C}$ ,  $450^{\circ}\text{C}$ ,  $550^{\circ}\text{C}$  to  $650^{\circ}\text{C}$ . The two processes are the same, unlike a process that ammonia was added and the other not.

Calcium Oxide ( $\text{CaO}$ ) has a potential to be developed as adsorbent material to capture  $\text{CO}_2$  at high temperature.  $\text{CO}_2$  could be capture using some adsorbent such as activated carbon and molecular sieve. However, these types of adsorbent are only active at low temperature and require high pressure. In example of gasification process, the effluent gases produced were usually in the form of hot gas stream (over  $600^{\circ}\text{C}$ ).  $\text{CaO}$ -based sorbent has been identified as the suitable candidate for this job [9]. In recent years, many researchers worked on enhancing the performance especially for multi-cycles of the  $\text{CaO}$  through various modification methods such as hydration, acid treatment and chemical doping. The ethanol-water hydration method was observed the simplest and economically to apply [10].

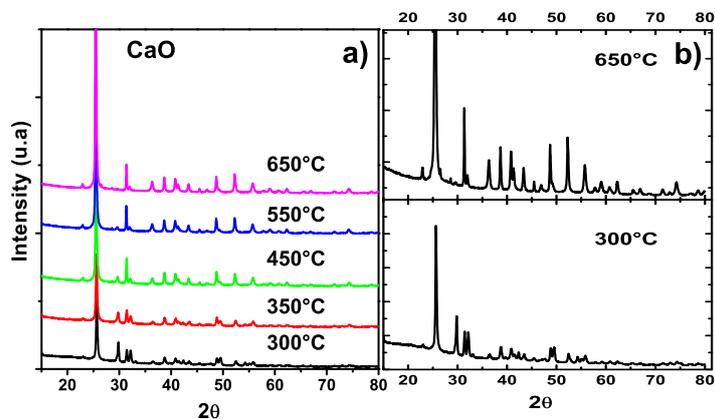
## 3. Results and discussion

In Figure 2, the SEM sample of  $\text{CaO}$  is observed, samples with ammonia have size less particle Figure 2(a) and (b). In Figure 2(c) and (d), have samples without ammonia, grain shape are small bars, the bar size increases with increasing temperature. We hope to make a comparison with these samples photodegradation; this is a job for the future. The photocatalytic removal of organics and its degradation efficiency will be evaluated by determination of reduction in the chemical oxygen demand values. The organic pollutant degradation efficiency is expected in a wide range of pH values, irradiation time and optimum catalyst load. In additional effects like aeration and stirring increase the photodegradation efficiency of organic.

The XRD pattern of  $\text{CaO}$  nanoparticles has been shown in Figure 3. All reflection peaks in Figure 3 can be readily indexed to a pure cubic phase of  $\text{CaO}$  with a Fm-3m space group. XRD patterns showed broadening of the peaks, indicative of the ultra-fine nature of the crystalline material. Figure (a), (b) are ammonia samples due to particle size, we have more interest in these.



**Figure 2.** SEM images of CaO NPs. Figure (a) and (b) with addition of ammonia at 450 and 650<sup>0</sup>C, (c) and (d) without added ammonia in the process; 450 and 650<sup>0</sup>C respectively.



**Figure 3.** The XRD pattern of CaO nanoparticles.

We intend to do tests with these nanoparticles in degradation of pesticides and as a bactericide. According to some works of literature the pesticides and herbicides, intentionally

released into the environment, are ubiquitous in aquatic systems; they are often detected at low levels and commonly occur in the form of complex mixtures [11]. Leaching of chemical fertilizers and pesticides, applied to agricultural and forest land, is one of the main reasons for organic pollution in several water streams. Pesticides and herbicides are harmful to life because of their toxicity, carcinogenicity and mutagenicity [11]. Therefore toxicity of pesticides and their degradation products is making these chemical substances a potential hazard by contaminating the environment. Others author say that samples of *CaO* respond well as antibacterial. With increasing calcination time, antibacterial activity of *CaO* nanoparticles was also increased [12].

#### 4. Acknowledgements

Authors acknowledge financial support from the agencies Colciencias Colombia and CNPq Brazil.

#### References

- [1] M T Arpin and S Yusup 2011 *Canad J Appl Sci* **5** 1391
- [2] S C Ameta, P B Punjabi, R Ameta, C Ameta 2014 *Microwave-assisted organic synthesis a green chemical approach 1st ed* (New York: CRC Press)
- [3] A Buasri, N Chaiyut, V Loyuenyong, P Worawanitchaphong and S tronyong 2013 *Sci Worl J Hind* **2013** 7
- [4] R M Nageeb 2013 *Adsorption Technique for the Removal of Organic Pollutants from Water and Wastewater* (Croatia: InTech) chapter 7 p 167
- [5] P Patnaik 2002 *Handbook of inorganic* (New York: McGraw-Hill)
- [6] European Commision Joint Research Centre 2001 *Integrated pollution prevention and control* (Seville: European Commission)
- [7] D J Harrison 1993 *Indistrial minerals laboratory limestone* (Nottingham: British Geological Survey)
- [8] M YGaceram, M C Pujol, M Aguilo and F Diaz 2007 *J Sol-Gel Sci Techn* **42** 79
- [9] C Yu, C Huang and C Tanr 2012 *Aeros Air Qual Reser* **12** 745
- [10] V Manovic, E J Anthonyr 2010 *Int J Environ Res Public* **8** 3129
- [11] H Liu, X Cai, Y Wang, J Chen 2011 *Water Research* **45** 3499
- [12] Z X Tangi, Z Yu, Z L Zhang, X Y Zhang, Q Pan and L E Shi 2013 *Quim Nova* **36** 933