Chemical Engineering Journal 211–212 (2012) 112–121

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

The properties of amorphous nano-silica synthesized by the dissolution of olivine

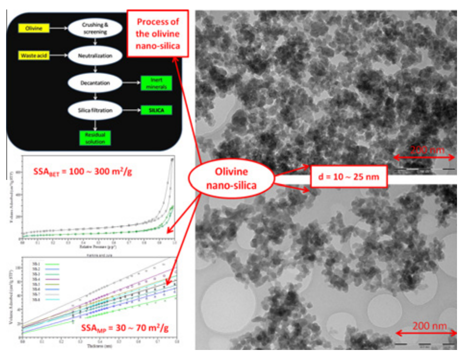
A. Lazaro [a,*], H.J.H. Brouwers [a], G. Quercia [a,b], J.W. Geus [c]

[a] Department of the Built Environment, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands
[b] Materials innovation institute (M2i), Delft, The Netherlands
[c] Debye Institute for Nanomaterials Science, University of Utrecht, Utrecht, The Netherlands

HIGHLIGHTS

- ▶ The dissolution of olivine produces an amorphous nano-silica of high quality.
- ▶ The SSA of this nano-silica is between 100 and 300 m^2/g.
- ▶ Olivine nano-silica has primary particles of 10–25 nm agglomerated in clusters.
- ▶ Olivine nano-silica is mesoporous with an average pore size around 20 nm.
- ▶ The texture of this silica depends on the olivine kinetics and the washing steps.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 6 June 2012
Received in revised form 23 August 2012
Accepted 14 September 2012
Available online 24 September 2012

Keywords:
Amorphous mesoporous nano-silica
Synthesis
Olivine
Specific surface area

ABSTRACT

This study addresses the synthesis of amorphous mesoporous nano-silica by the dissolution of olivine in sulfuric acid, showing the influence of the process conditions on the properties of nano-silica. The olivine dissolution process is a convenient alternative to the traditional methods of nano-silica production; and that is because the low energy requirement makes it possible to use this material in new fields where previously its price was prohibitive. The produced nano-silica has a specific surface area between 100 and 300 m^2/g and a particle size between 10 and 25 nm. These particles are agglomerated in clusters forming a mesoporous material with an average pore diameter around 20 nm. The impurity content is below 5%, and the silica yield of the process in the range of 54–83%. When the separation of the silica is carried out by filtration, the textural properties of the material have a direct influence on the separation efficiency. The texture and specific surface area of nano-silica depends on several factors of the process, the main ones being the kinetics of the dissolution of olivine and the washing steps of the nano-silica. Thus, the properties of this nano-silica can be tailored by changing the process conditions.

1. Introduction

At present a wide range of silica products are manufactured industrially for various applications. Silicas are mainly used for reinforcement of elastomer products, thickening of liquid systems such as paints, thermosetting resins, and printing inks, and as fillers in silicone rubber [1]. World demand for specialty silicas, which includes precipitated silica, fumed silica, silica gel and silica sol, was 1.9 million metric tons in 2009 and will rise to 2.7 million metric tons in 2014 with a total value of \$5.8 billion [2], making it one of the most used nano-materials. Nowadays, the two most important commercial processes in the production of nano-silica are the neutralization of sodium silicate solutions with acid (this material is referred as precipitated silica) and the flame hydrolysis (pyrogenic silica). Both processes are expensive because of the price of the raw materials and the energy requirements. Nano-silica could be applied even more widely if a new industrial, low cost, production process could be developed.

* Corresponding author. Tel.: +31 (0)40 247 3411.
E-mail address: a.lazaro.garcia@tue.nl (A. Lazaro).

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http://dx.doi.org/10.1016/j.cej.2012.09.042