Journal of Alloys and Compounds 690 (2017) 730–740

Contents lists available at ScienceDirect

Journal of Alloys and Compounds

journal homepage: http://www.elsevier.com/locate/jalcom

Mimosa pudica mediated praseodymium substituted calcium silicate nanostructures for white LED application

R.B. Basavaraj [a], H. Nagabhushana [a,*], B. Daruka Prasad [b], S.C. Sharma [c], K.N. Venkatachalaiah [d,e]

[a] Prof. C.N.R. Rao Centre for Advanced Materials, Tumkur University, Tumkur, 572 103, India
[b] Department of Physics, BMS Institute of Technology and Management, VTU Affiliated, Bengaluru, 560064, India
[c] Dayananda Sagar University, Shavige Malleshwara Hills, Kumaraswamy Layout, Bengaluru, 560078, Karnataka, India
[d] Amrita School of Engineering, Bangalore Campus, Amrita Vishwa-vidyapeetam, Bengaluru, 560 035, India
[e] Research and Development Centre, Bharathiar University, Coimbatore, 641046, India

ARTICLE INFO

Article history:
Received 9 January 2016
Received in revised form
7 August 2016
Accepted 8 August 2016
Available online 10 August 2016

Keywords:
Calcium silicates
Superstructures
Mimosa pudica
Judd-Ofelt analysis
Photoluminescence

ABSTRACT

In this paper a simple green route was adopted for the synthesis of orange light emitting $CaSiO_3$:Pr^{3+} (1–11 mol %) phosphors using *Mimosa pudica* L. extract as a fuel. The final product was well characterized by powder X-ray diffraction (PXRD), Fourier transform infra-red spectroscopy, diffuse reflectance spectroscopy (DRS), scanning electron microscopy (SEM) and transmission electron microscopy. The concentration of plant extract plays an important role in controlling the morphology as well as the formation of superstructures. The obtained superstructures from SEM studies resembled the naturally existing structures like dates, cactus, coconut shell, etc. The energy band gap estimated using DRS was found to be in the range of 5.23–5.47 eV. The emission peaks at 550, 606, 650 and 733 nm were due to the transitions of $^3P_0 \rightarrow {}^3H_{4,5}, {}^3F_{2,3}$. The Commission International de I 'Eclairage and colour correlated temperature coordinates were estimated for all the concentrations of Pr^{3+} ions and the results indicates that the phosphor may be quite useful in cool light source. The crystalline nature and phase was confirmed by PXRD for the calcined samples at 950 °C for 3 h. This was the lowest formation temperature reported in the literature for Pr^{3+} doped $CaSiO_3$. FTIR results showed the stretching vibrations of Si-O at 720 cm^{-1}, asymmetric stretching vibrations of Si-O-Si bonds at 560 cm^{-1}. The present preparation method was simple, eco-friendly, inexpensive and free from unwanted by-products which can be used for large scale production.

1. Introduction

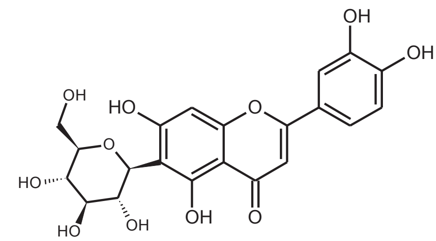
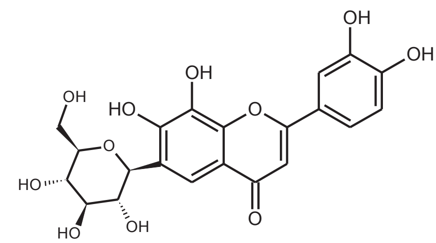
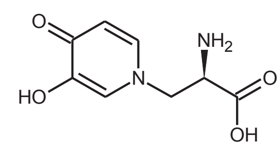
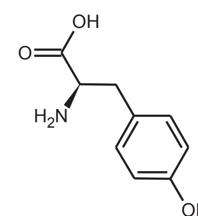
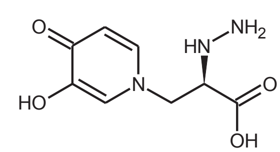
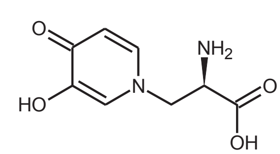
Recently, silicate as a host lattice and rare earth (RE) ions as dopants was envisioned science community due to their potentiality in to the fields of optoelectronics, biotechnology and medical [1–3]. Many reports were available in literature as a potential candidate for single component of white LEDs. Sahu et al. reported the emission of white light by $CaMgSi_2O_6$: Dy^{3+} silicates due to the combination of red, blue and yellow components from the various electronic transitions. This material was suitable for sensors to detect the stress of an object [4]. Manohara et al. prepared doped Cr^{3+} ions to $CdSiO_3$ phosphor materials by low temperature technique and showed its compatibility as a red component of WLED's [5]. Silicates with flakes like structure showed the potentiality in the field of lithium ion batteries as a cathode material [6]. Shirazi et al. reported the effect of loading of silver and tantalum on the biological properties of calcium silicates [7] Kerativitayanan et al. reported the use of biocompatible nanosilicate based composite as a part of artificial stem cells [8]. These varieties of applications from silicates is due to the co-existence of both ionic and covalent nature of bonds which helps to implant and provides easy moment of doped (RE) ions into the host matrix.

Normally, silicates were prepared by solid state, co-precipitation, evaporative decomposition, aerosols hydrolysis, sol–gel etc. [9–15] which requires the formation temperature at above 1200 °C leads to the strong aggregation of particles. Further, wet chemical methods require long processing time, costly chemicals and elaborate experimental setup.

* Corresponding author.
E-mail address: bhushanvlc@gmail.com (H. Nagabhushana).

http://dx.doi.org/10.1016/j.jallcom.2016.08.064
0925-8388/

Table 1
Major bioactive compounds in the natural leaves extract of the *Mimosa Pudica.*

Sl No.	Chemical Name	Structure
1.	5,7,3,4-tetrahydroxyl-6-C-beta-D-glucopyranosyl flavones	
2.	7,8,3,4-tetrahydroxyl-6-C-beta-D-glucopyranosyl flavone	
3.	Mimosine	
4.	Tyrosine	
5.	M mimosinamine	
6.	Mimosinic acid	

Therefore simple and viable methods which replace the complex chemical routes are essential and can be achieved by using naturally occurring sources. Specific nanostructures with high surface reactivity in the nano-scale and an added advantages such as in-expensive and eco-friendly methods using bacteria [16], fungus [17] and plants extracts were reported in recent years [18–22]. Further, these methods also offer some valuable benefits in electron density distributions and special electronic and optical phenomena as compared to the regularly prepared chemical and physical synthesis routes. Till date there were no reports available for the synthesis of calcium silicate nano/micro superstructures by green chemistry route. In recent time, environmental friendly approach for the synthesis of nanoparticles using plant extracts namely leaf/root/latex/seed and stem seem to be the best candidates as they are suitable for large-scale production. Secondly the method offers a numerous advantages such as ecofriendly, cost-effectiveness, quick and produces large quantities of nano/micro structured materials. However these plant extracts not only act as a reducing agent but also as capping agents, which in turn produces self-assembled superstructures [23–25].

Nowadays silicate based nanostructures are considered to be the potential host candidate for luminescence phenomena due to their high thermal stability, thermal expansion coefficient, chemical inertness and conductivity for display devices with higher luminous efficiency on doping with rare earth ions [26–35].

Mimosa pudica belong to the family of *Mimosae* known as sensitive plant in English. This plant was a shrub in nature and distributed in moist locality. The leaves of this plant were commonly used in the treatment for vulnerary, alexipharmic, antispasmodic, febrifuge etc. [36,37]. Various phytochemicals namely steroids, carbohydrates, flavonoids, tannins, saponins etc. were present in the extract and their structures are shown in