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Synthesis and characterization of pure and Zn-doped talc

M. Catalano (1), A. Bloise (2), E. Belluso (3,4,5), C. Apollaro (6), D. Miriello (7), T. Critelli (8), E. Barrese (9), E. Cazzanelli (10), and G. M. Crisci (11)

(1) Department of Physics, Unical, Rende, Italy (manuela.catalano@fis.unical.it), (2) Department of Earth Sciences, Unical, Rende, Italy (andrea.bloise@unical.it), (3) Department of Earth Sciences, Unito, Torino, Italy (elena.belluso@unito.it), (4) Geosciences and Geo-resources Institute (CNR), Torino section, Torino, Italy (elena.belluso@unito.it), (5) NIS Centre of Excellence, Torino, Italy (elena.belluso@unito.it), (6) Department of Earth Sciences, Unical, Rende, Italy (apollaro@unical.it), (7) Department of Earth Sciences, Unical, Rende, Italy (Miriello@unical.it), (8) Department of Earth Sciences, Unical, Rende, Italy (teresa.critelli@unical.it), (9) Department of Earth Sciences, Unical, Rende, Italy (e.barrese@unical.it), (10) Department of Physics, Unical, Rende, Italy (enzo.cazzanelli@fis.unical.it), (11) Department of Earth Sciences, Unical, Rende, Italy (crisci@unical.it)

Talc $Mg_3Si_4O_{10}(OH)_2$ is a trioctahedral phyllosilicates in which the layers are built from brucite-type $Mg(OH)_2$ sheet sandwiched between two silicon-oxigen tetrahedral sheets. Talc usually crystallizes in lamellae, sometimes it shows fibrous morphology. The low cost and good properties (i. e., resistant to heat and acids, hydrophobic, electrical insulating) make talc an ideal surface for lab counter tops and electrical switchboards. It is also widely used in many different products such as ceramics, papers, cosmetics, foods, polymers, etc. To find others applications, in recent years syntheses and property studies have been conducted on pure and doped talc. To this aim, syntheses of pure and Zn-doped talc with partial or total substitution of Mg^{2+} with Zn^{2+} were carried out in order to elucidate the best conditions of its formation and to assess the potential for industrial applications. Many synthesises were performed using oxides as starting materials with different ratio between magnesium and zinc oxide, under controlled hydrothermal conditions. The starting mixtures for three different set of runs were as follow:

a) cristobalite, magnesium oxide;

b) cristobalite, magnesium oxide, zinc oxide;

c) cristobalite, zinc oxide.

About 60 mg of finely powdered starting mixture were mixed with two types of reactants (α) H_2O; (β) H_2O + $CaCl_2$ added in amount ranging from 5 to 16 wt % and put within a sealed platinum capsule to react in externally heated pressure vessel. Several runs were carried out with temperature ranging from 300 ˚C to 650 ˚C, pressure of 2 kbar and reaction time of 160 hours. The products were examined by XRPD and SEM/EDS. As revealed by XRPD patterns, talc as unique phase has been obtained only when at the starting mixture a) was added the reactant (β).Willemite (Zn_2SiO_4) and quartz were detected in variable amount in all the other runs. Zn-doped talc was obtained from mixture b) using either (α) or (β) reactants. Zn-doped talc crystals grow small in size and poorly shaped when Zn^{2+} was in large amounts in the starting mixtures and they were not obtained when the metal put in was only Zn^{2+}. Talc showed lamellar morphology when reactant (α) was added to the starting mixture (300-650 ˚C, 2 kbar, 160 h) and it exhibited both lamellar and fibrous morphology at the same hydrothermal conditions, only when reactant (β) was added to the starting mixture. Lamellae average size was of about 15 μm while fibres length ranging from 100 to 30 μm. ZnO ranging from 5.95 to 16.95 wt% (11.55 wt% in average) and from 8.13 to 5.33 wt% (6.74 wt% in average) in lamellae and fibres respectively. EDS/SEM analyses on all fibrous talc samples showed low amount of Ca^{2+} (deriving from $CaCl_2$) and it could be involved in the fibrous growth. The best conditions for greatest lengthening of Zn-doped talc fibres and bigger lamellae, are respectively at 650 ˚C and 500 ˚C (2 kbar, 160h). In order to characterize in detail lamellar and fibrous talc, TEM, TG/DSC and micro-Raman investigations are in progress.