

The microstructural study of clay minerals - polymer matrix nanocomposites.

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Clay minerals (layered silicates) have been used as reinforcing filler for polymers. Montmorillonite (MMT) has well-known 2:1 layered structure where the central octahedral alumina sheet is sandwiched by two tetrahedral silicate sheets with cations such as Na⁺ or Ca²⁺, which are present between layers to compensate the net negative charge. The lateral dimensions of MMT particles vary from tens to hundreds of nm. The interlayer cations can be replaced by organic molecules through an intercalation and further exfoliation. Two processes were crucially important: the ability of MMT particles to intercalation and exfoliation and the dispersion of the clay particles in the polymer matrix. The MMT particles, organomodified particles and 1, 3, 5 и 30 wt% MMT filled polymer (polyimide) were studied by transmission electron microscopy and microanalysis. The interplanar distance in the MMT particles determined from the number of high resolution images and electron diffraction pattern was found to be of $c=0.99\pm 0.01$ nm. The edge type dislocation with projection of burgers vector $\mathbf{b}=c[001]$ were observed. The interplanar distance c in the organomodified particles mostly increase to 2.2 – 2.5 nm together with the growth of dislocation density. The study of MMT-polymer nanocomposites demonstrated the enhancement of particles dispersion in the range of 1 to 5 wt% filled polymer with the growth of the exfoliated particles density. Much less exfoliation of the MMT particles were found in 30 wt% filled composite together with formation of high density of pores, observed in these TEM specimens.

The work was supported by grant N 16.253.11.306.

Phase relations of carbonate eclogite during subduction and the effect of redox conditions on diamond – carbonate reactions

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High pressure experiments are critical to understanding the recycling of carbon into the deep earth during subduction processes [1,2]. Melting and phase relations of carbonate eclogites (former altered oceanic crust) and the effect of oxygen fugacity on diamond versus carbonate stability along deep subduction geotherms are currently very poorly understood.

To investigate this, a series of piston-cylinder experiments was conducted at $P=3.5-6.0$ GPa, and $T=900-1300^\circ\text{C}$. Starting material for the first part of the study models highly carbonated (10% CaCO_3) altered oceanic basalt [1]. Experiments at reduced conditions (using Fe capsules) showed the absence of crystalline carbonate and the presence of siliceous near-solidus melts. In high oxygen fugacity experiments, performed using a Re-ReO₂ buffer at 1000-1100°C, carbon was present as carbonates at high pressure (5.5GPa) and in carbonate-silicate melt at low pressure (3.5 GPa).

The stability of carbon versus carbonate in subducting C-bearing eclogite may be defined by reaction $\text{CaMg}(\text{CO}_3)_2 + 2\text{SiO}_2 = \text{CaMgSi}_2\text{O}_6 + 2\text{C} + 2\text{O}_2$ [3]. This reaction is being investigated in a second series of experiments with compositionally variable carbonate eclogites (mixes of synthetic garnet, clinopyroxene, kyanite, coesite, dolomite and Ir metal as a redox sensor) being used to determine P-T- $f\text{O}_2$ -X phase relations. Garnet Fe³⁺ contents will be determined using the electron microprobe based flank method [4] and the synchrotron based Fe K-edge XANES method [5].

[1] Yaxley & Green (1994) *EPSL* **128**, 313-325. [2] Dasgupta *et al.* (2004) *EPSL* **227**, 73-85. [3] Luth (1993) *Science* **261**, 66-68 [4] Höfer, Brey (2007) *Am.Min.* **92**, 873-885 [5] Berry *et al.* (2010) *Chem.Geol.* **278**,31-37