# Radiation damage evolution in nanocomposites

BLAS PEDRO UBERUAGA

Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, NM 87545; correspondence: blas@lanl.gov

As nuclear energy systems are taken to higher levels of radiation damage, there is greater need to develop materials that can withstand that damage. Nanocomposites, nanomaterials comprised of both a high density of internal interfaces and second phases, are one promising avenue for such materials. Most work on nanomaterials has focused on the role of the interfaces as sinks of point defects. Here, motivated by a series of experimental studies on oxide composites, we examine the other component of nanocomposites, the dual phase nature of the material without the interfaces acting as defect sinks. We solve a reaction-diffusion model of defect evolution of simple composites under irradiation which depends on defect properties within each phase with no special behavior accounted for at the interface. We identify three regimes of steady-state defect behavior that depend on the relative thermodynamics and kinetics of the defects in the phases comprising the composite. Importantly, in one regime, defect populations are enhanced on one side of the interface and depleted on the other. Further, transient defect populations can exceed steady-state concentrations. We conclude that the evolution of irradiation-induced defects in one phase of the composite is strongly controlled by the defect properties of the other phase, offering a route to controlling defect evolution in these materials.

# Magmatic processes revealed by heterogeneous crystal populations in a lamprophyre system

T. UBIDE[1,2]*, C. GALÉ[1], P. LARREA[1], E. ARRANZ[1], M.LAGO[1] AND J.R. WIJBRANS[2]

[1]Universidad de Zaragoza, Spain (*correspondence: tubide@unizar.es)
[2]VU University Amsterdam, The Netherlands

Minerals respond texturally and compositionally to changing magmatic environments. We have studied a Cretaceous alkaline lamprophyre intrusion cropping out in the Catalonian Coastal Ranges in NE Spain [1] which includes macrocrysts and microcrysts of clinopyroxene and amphibole with complex zoning patterns. Mineral textures, compositional zoning, barometric estimates and geochronology provide insights into the magma plumbing system.

Macrocryst cores show inverse zoning patterns from more evolved to more primitive compositions. Therefore, they are not in equilibrium with the magma that hosts them and cannot be considered true phenocrysts. Rather, they are classified as antecrysts [2] recycled from earlier stages of the magma system. Macrocryst rims and microcrysts, in contrast, define an evolution from more primitive to more evolved compositions that can be related to progressive fractionation of the magma.

According to clinopyroxene barometry [3], macrocryst cores crystallised in a deep magma chamber (500-800 MPa) whereas macrocryst rims and microcrysts crystallised during the ascent and shallow emplacement of the magma below 50 MPa pressure. $^{40}Ar/^{39}Ar$ ages reveal a short timespan between the crystallisation of macrocrysts and microcrysts.

Our results reveal repeated injection and mixing of batches of a more primitive magma with the resident magma in a deep magma chamber, controlling the crystallisation of macrocryst cores (antecrysts). The last recharge event likely triggered the ascent of the magma to the emplacement level, carrying a significant amount of recycled crystals. The melt underwent fractionation during ascent and emplacement, controlling the composition of macrocryst rims and microcrysts.

This investigation highlights the need to carefully evaluate mineral zoning patterns and mineral-melt equilibrium in apparently simple porphyritic rocks.

[1] Ubide *et al.* (2012) *Lithos* **132-133**, 37-49. [2] Davidson *et al.* (2007) *Annu. Rev. Earth Planet. Sci.* **35**, 273–311. [3] Putirka (2008) *Rev. Mineral. Geochem.* **69**, 61-120.


DOI:10.1180/minmag.2013.077.5.21