Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.5396

Polychromatic polarization and the good old microscope: new avenues for the microstructural imaging of geological materials

BERNARDO CESARE[1] AND MICHAEL SHRIBAK[2]

[1]University of Padova

[2]University of Chicago

Presenting Author: bernardo.cesare@unipd.it

The polarizing microscope, fundamental tool for any first characterization of geological materials, suffers from one major limitation, namely the poor ability to image microstructures where minerals have a retardance <400 nm and display interference colors in the gray scale.

This problem, so far considered as intrinsic and unsolvable, has prevented detailed optical observation of many low-birefringence (e.g., quartz, feldspars, leucite) or quasi-isotropic (e.g., garnet) rock-forming minerals. For the microstructural analysis of these phases, alternative microscopic techniques, mostly electronic, have been developed and are routinely used.

Polychromatic polarization microscopy (PPM; [1]) is a new optical technique that overcomes the above limitations and allows inspection of materials with retardation from 1 to 400 nm. This is achieved by means of a full spectrum color palette where the hue depends on orientation of the slow axis and the saturation depends on the retardance amount.

We have applied PPM to regular, glass-covered 30 µm rock thin sections, with particular interest for the subtle birefringence of garnet, due both non-cubic growth [2] or to strain induced by external stresses or by mineral inclusions. PPM produces striking, colorful images that highlight different types of microstructures in very low retardance phases, which are virtually undetectable by conventional polarizing microscopy ppm (Fig. 1). The calibrated hue scale provides straightforward measurement of the orientation of optical axes in the thin section.

PPM will open new avenues for microstructural analysis of geological materials. We highlight two of them. On one hand the direct detection and imaging of microstructures will provide a fast and cheap alternative (or complement) to time-consuming and more expensive SEM-based analyses such as, e.g., EBSD. On the other hand this powerful imaging method will provide – again in a very fast way – a much better texturally constrained basis for the location of targets for cutting-edge applications such as, e.g., FIB-TEM or Atom Probe.

References:

[1] Shribak (2015) *Sci Rep* 5, 17340.

[2] Cesare et al. (2019) *Sci Rep* 9, 14672.

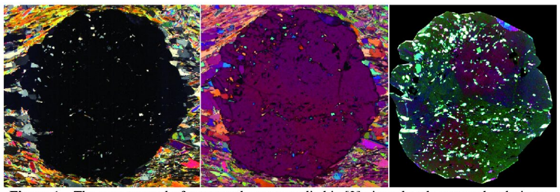

Figure 1 – The same crystal of tetragonal garnet studied in [2] viewed under crossed-polarizers (left), with the λ plate (center), and under PPM (right). The thin section is glass-covered and has a regular 30-µm thickness.