MICROSCOPICAL EXPLORATION

THIRTY ONE

HOME-MADE STICKY TAPE OPTICAL RETARDERS (HOW THEY ARE MADE AND WHAT THEY DO)

It may not have escaped the notice of regular readers of Micscape Magazine that extensive use of polarising filters and optical retarders (waveplates) is made during the 'Microscopical Explorations' which regularly appear therein.
The retarders used here are not the expensive high precision commercial devices which are described and explained here, but are simple home-made alternatives which follow the same scientific principles but are constructed by the application of transparent office sticky tape to standard 3"x 1" plane glass microscope slides.
The tape chosen for the construction of the retarders used here is the commonplace 25mm wide 3M Scotch 508 Easy Tear Tape, which is made of a biaxially-oriented polypropylene film coated with a water based synthetic acrylic adhesive (ref: here).
Biaxially-oriented polypropylene film has been stretched, during manufacture, in both the machine direction (along its length) and in the transverse direction (across its width), producing polymer chain orientation in two directions. This gives rise to birefringence, which is a material property pertaining to a difference in refractive index dependent on the polarisation and propagation direction of light passing through the material. The adhesive coating is isotropic and does not contribute to the birefringence of the sticky tape. When placed between a linear polarising filter and an analyser in crossed configuration at extinction, the birefringence of the sticky tape results in interference colours dependent upon the total thickness of the tape layers applied during construction of the retarder.
A series of twelve sticky tape retarders was made, as detailed in the following table, which generate the background interference colours stated in the table and shown in the images below.

Retarder No.	Sticky Tape Layers	Orientation of machine direction of tape layers to long edges of slide	Background Colour Between Crossed Polars
1	1	parallel	yellow
2	1	90°	yellow
3	2	parallel	green
4	2	90°	green
5	3	parallel	blue
6	3	90°	blue
7	4	parallel	red
8	4	90°	red
9	2	1 x 45° rotated right 1 x 45°rotated left	Dark
10	3	1 x90° 1 x 15° rotated left 1 x 45°l rotated eft	Dark
11	3	1 x parallel 1 x 20° rotated left 1 x 30° rotated left	Light (cream)
12	3	1 x parallel 1 x 11° rotated left 1 x 22° rotated left	Light (grey)

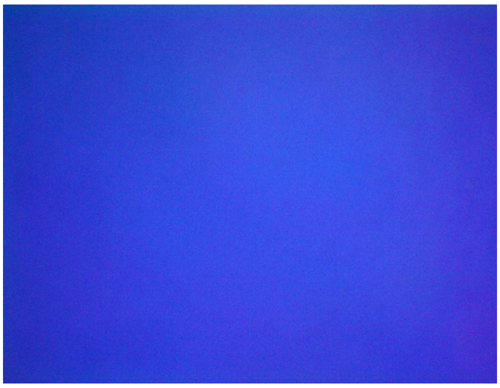
Retarder 1

Retarder 2

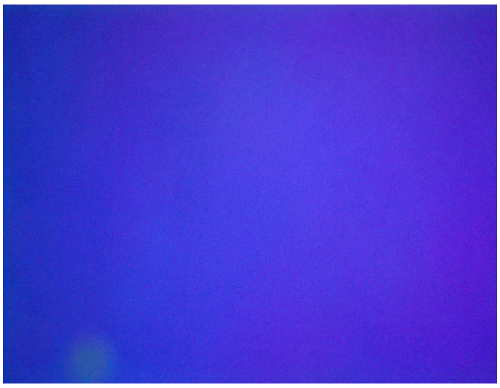
Retarder3

Retarder4

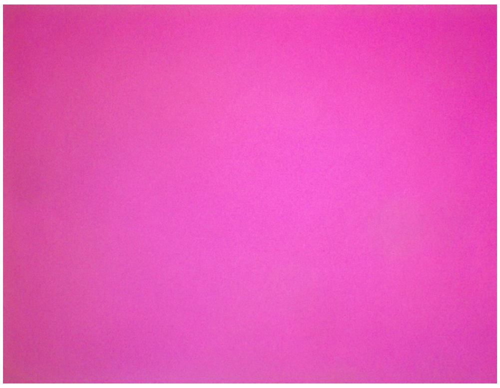
Retarder5



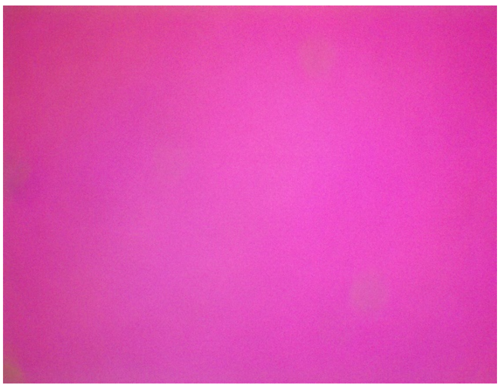
Retarder 6



Retarder 7



Retarder8



Retarder9

Retarder10

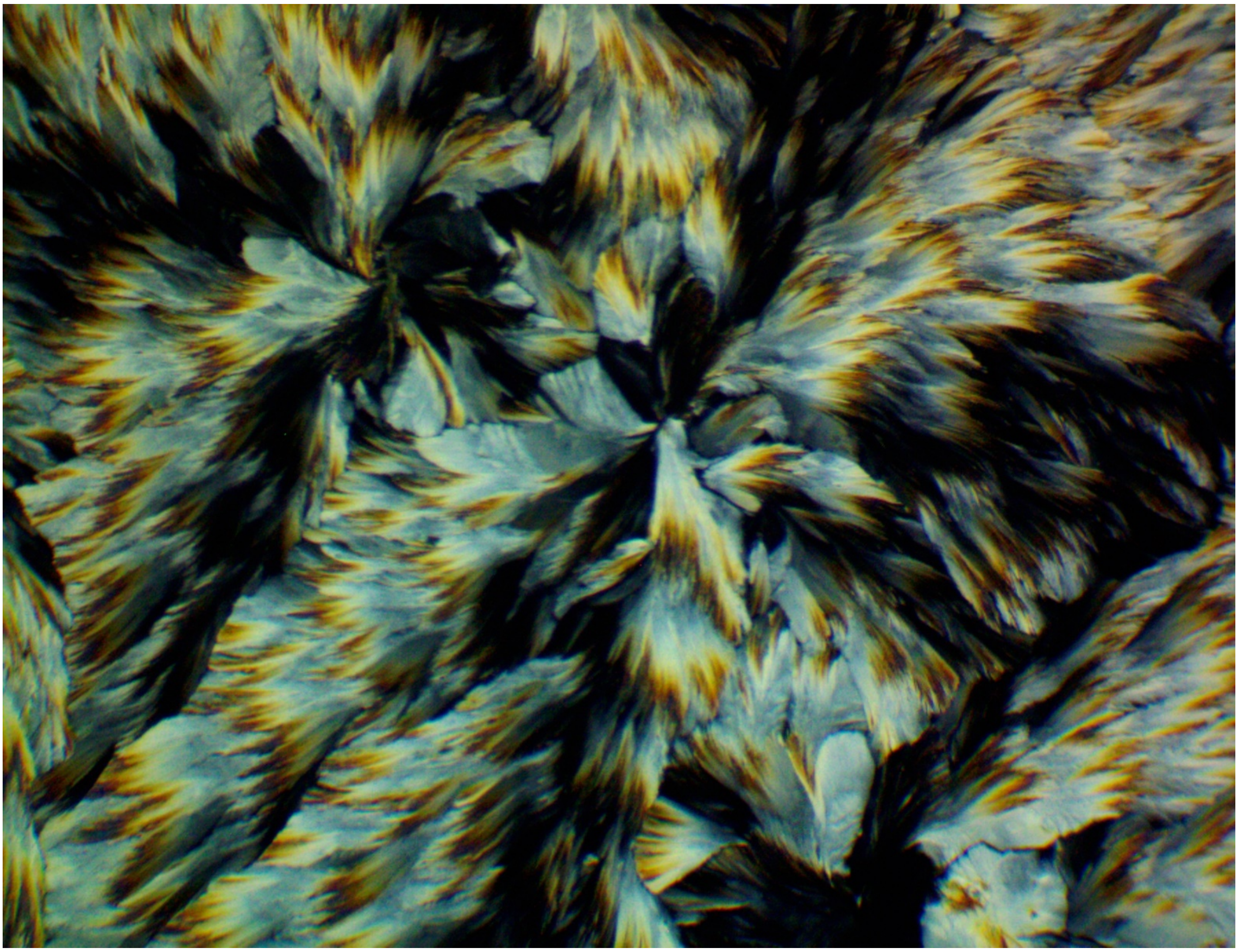
Retarder11

Retarder12

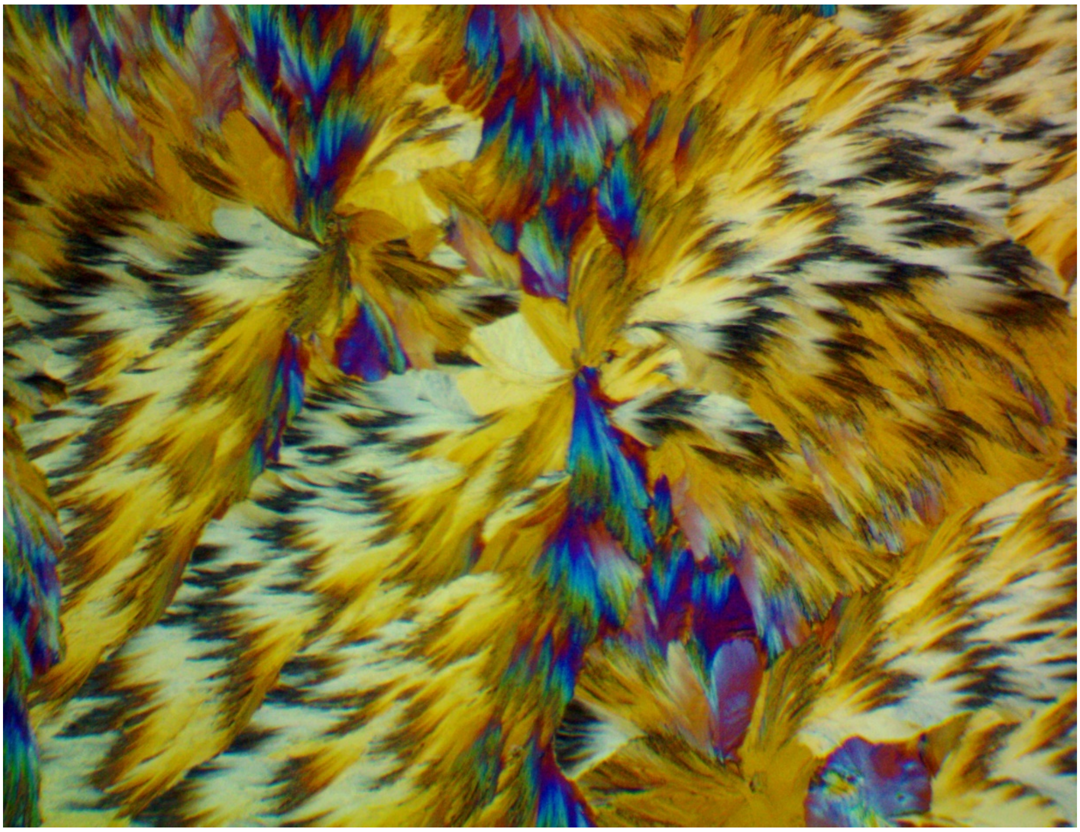
It can be deduced from the information in the table and from some of the background interference colours observed, that, as well as total thickness, the orientation of the layers of sticky tape to each other is also important in determining the overall effect of each retarder.

To illustrate the differences in the overall effect of each retarder, a specimen slide of tartaric acid crystals was observed between crossed linear polariser and analyser at extinction with no retarder, and then with each numbered retarder, in turn, inserted into the light path between polariser and specimen slide.

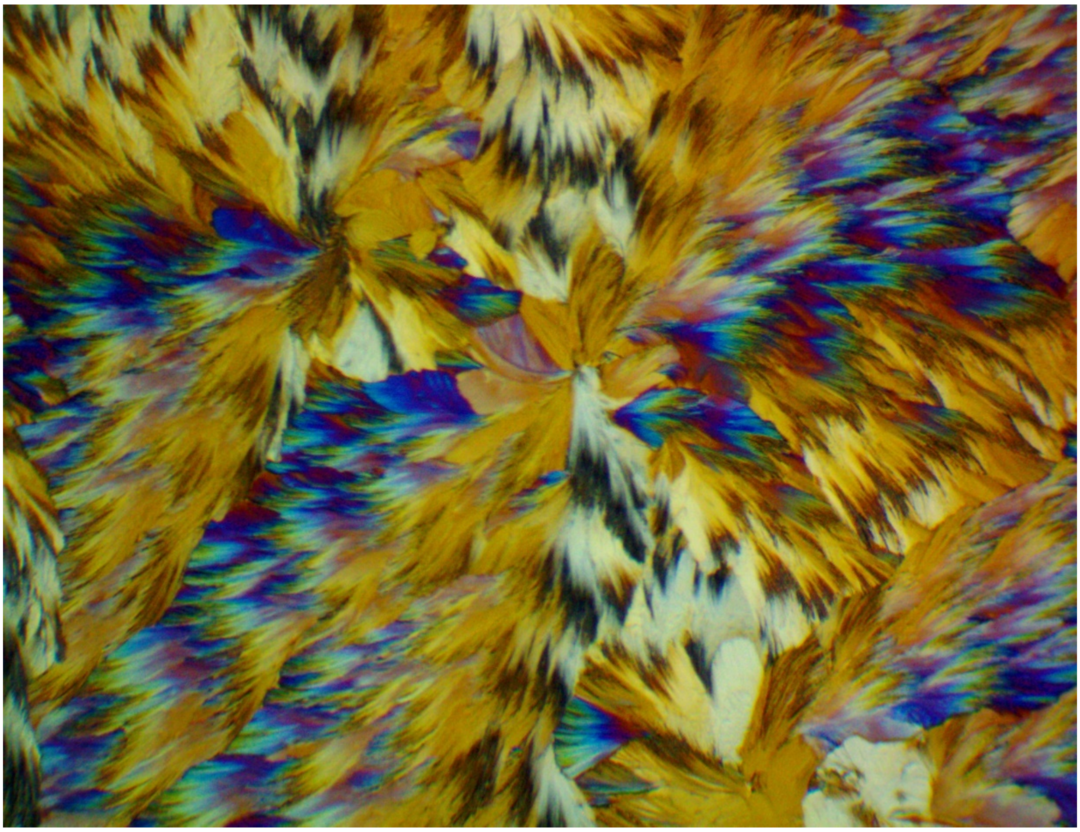
Specimen with no retarder



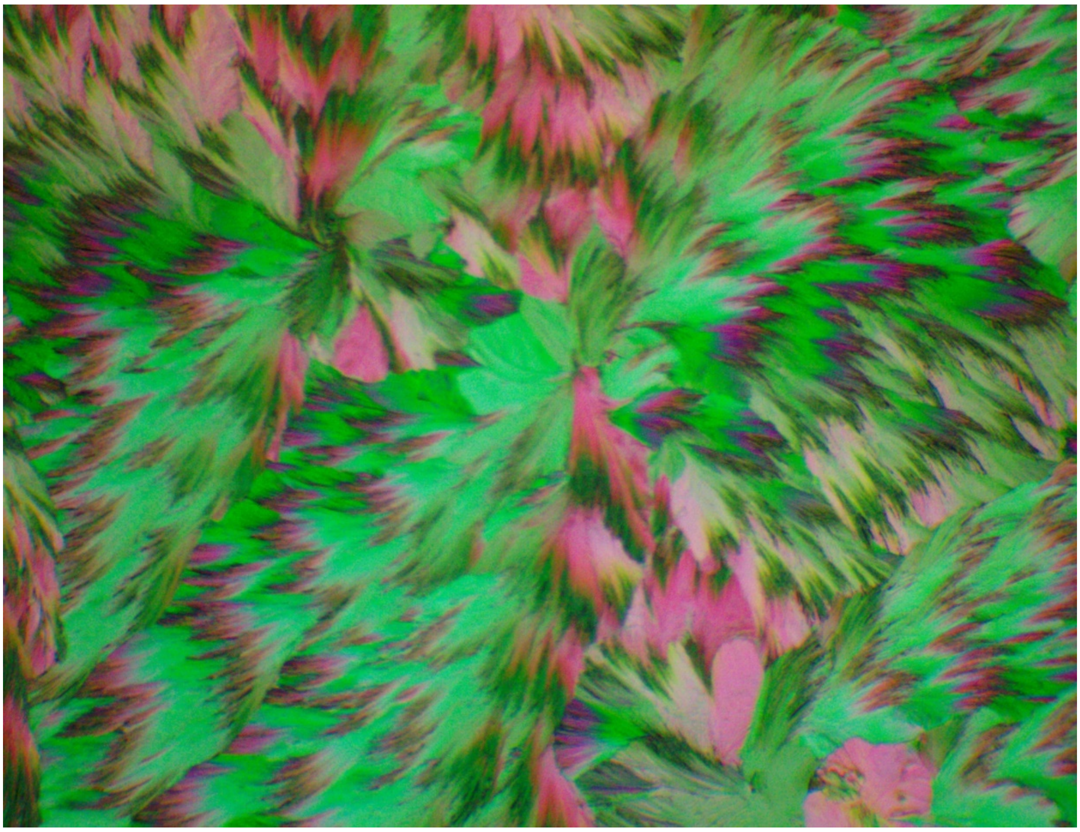
Specimen with retarder 1



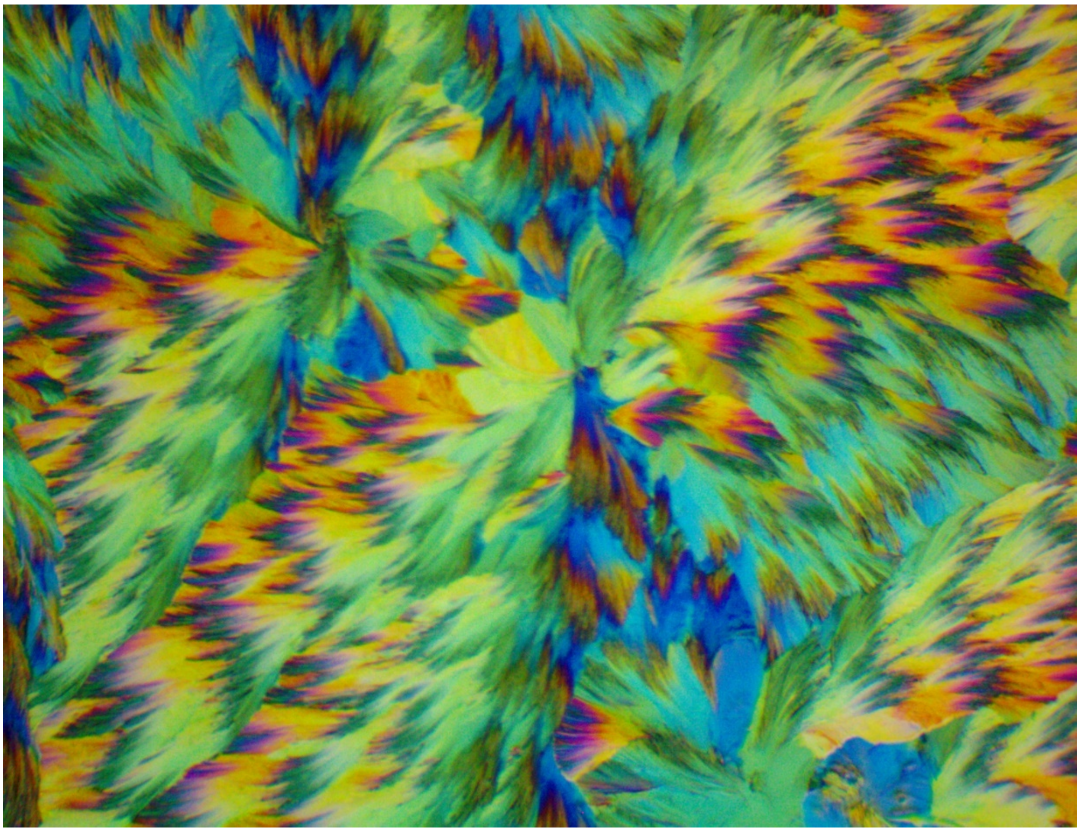
Specimen with retarder 2



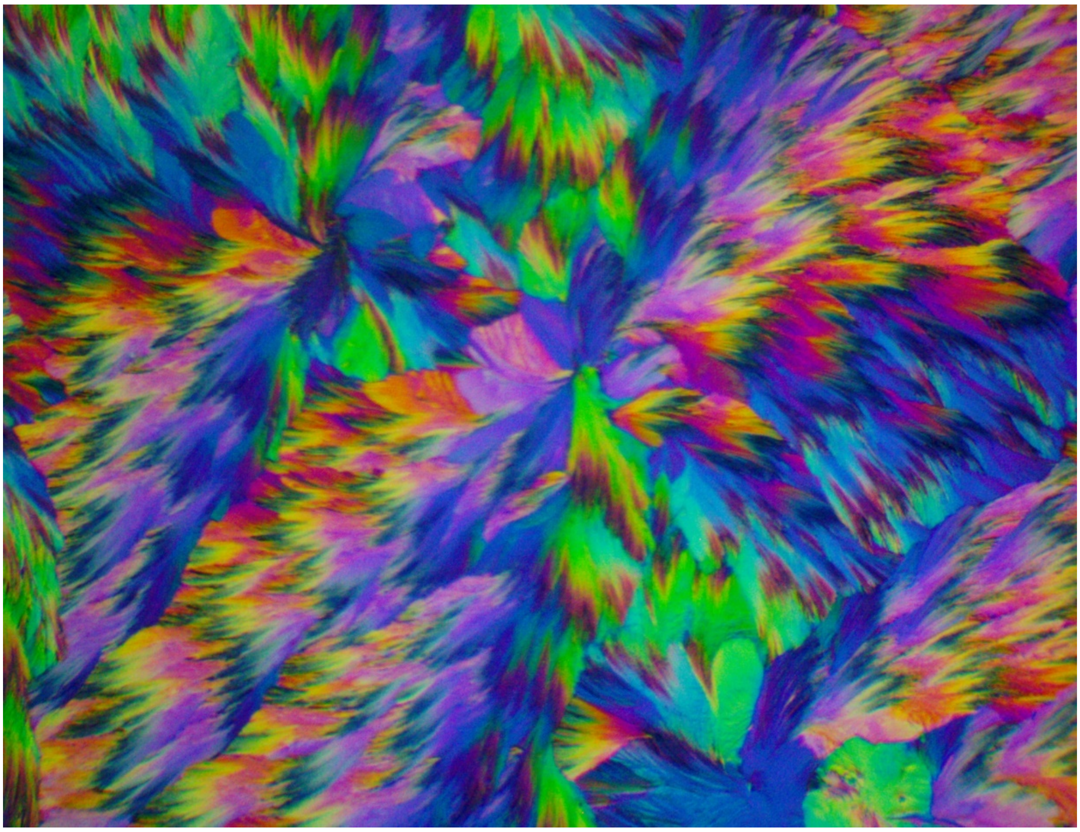
Specimen with retarder 3



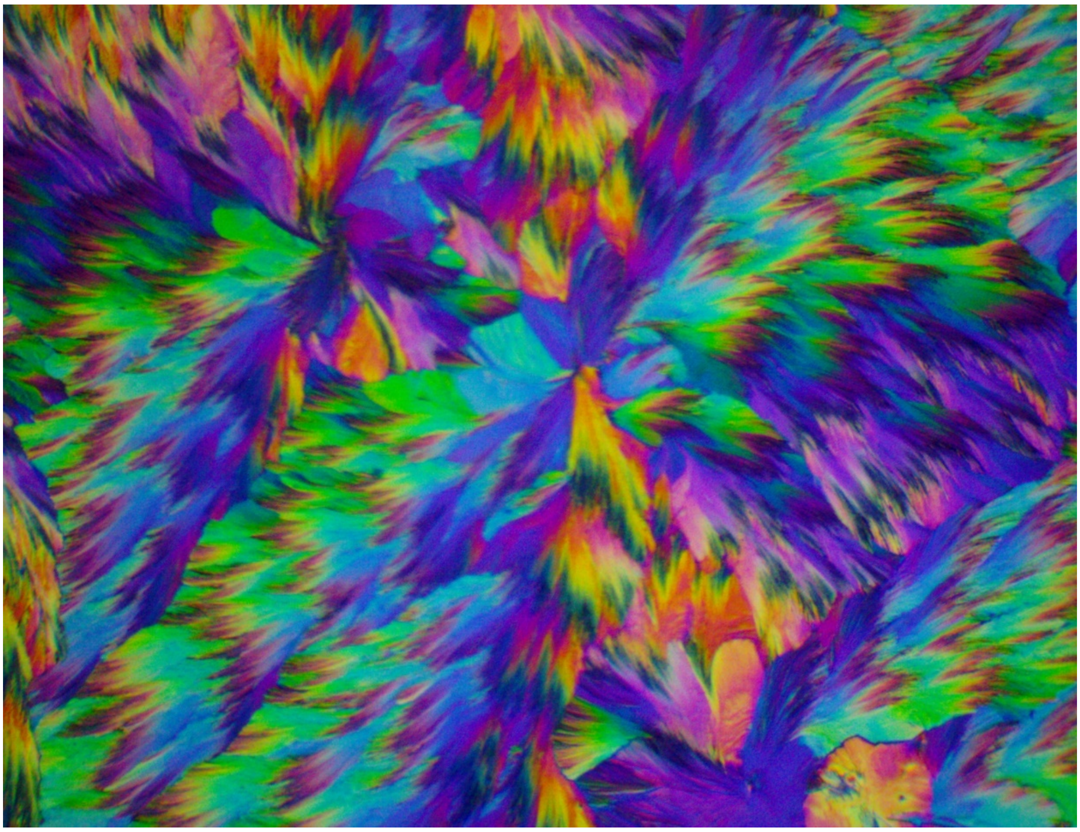
Specimen with retarder 4



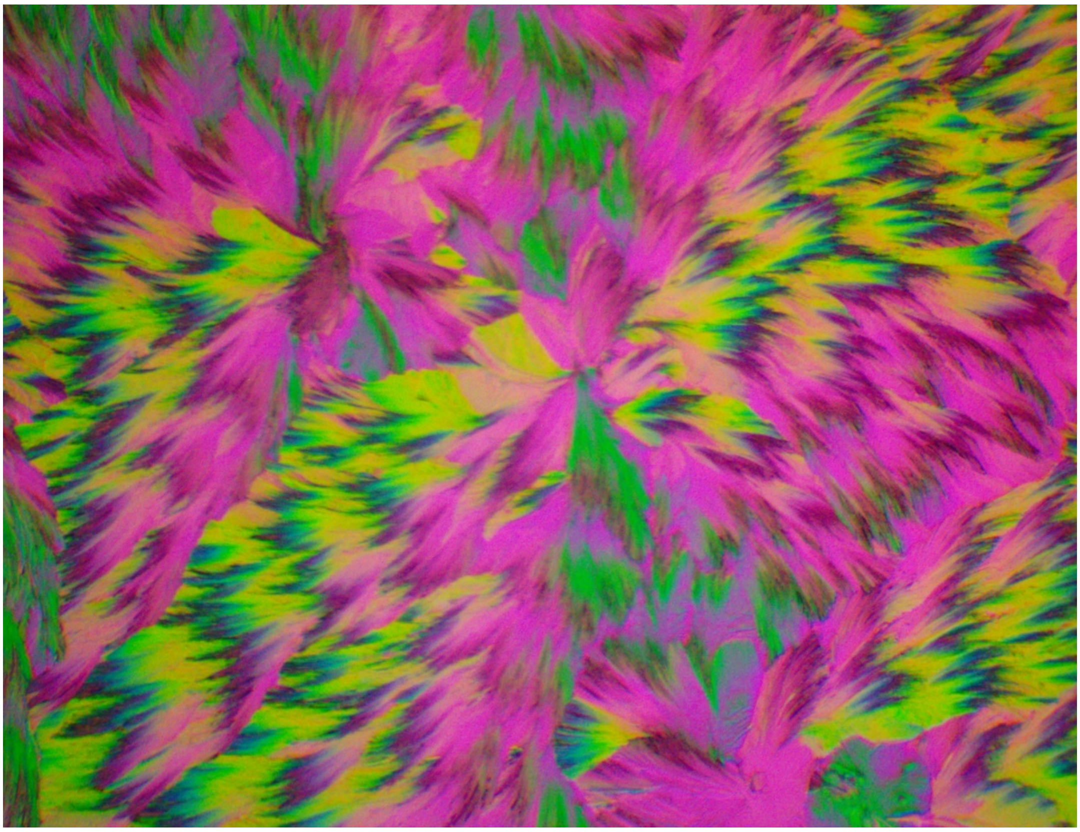
Specimen with retarder 5



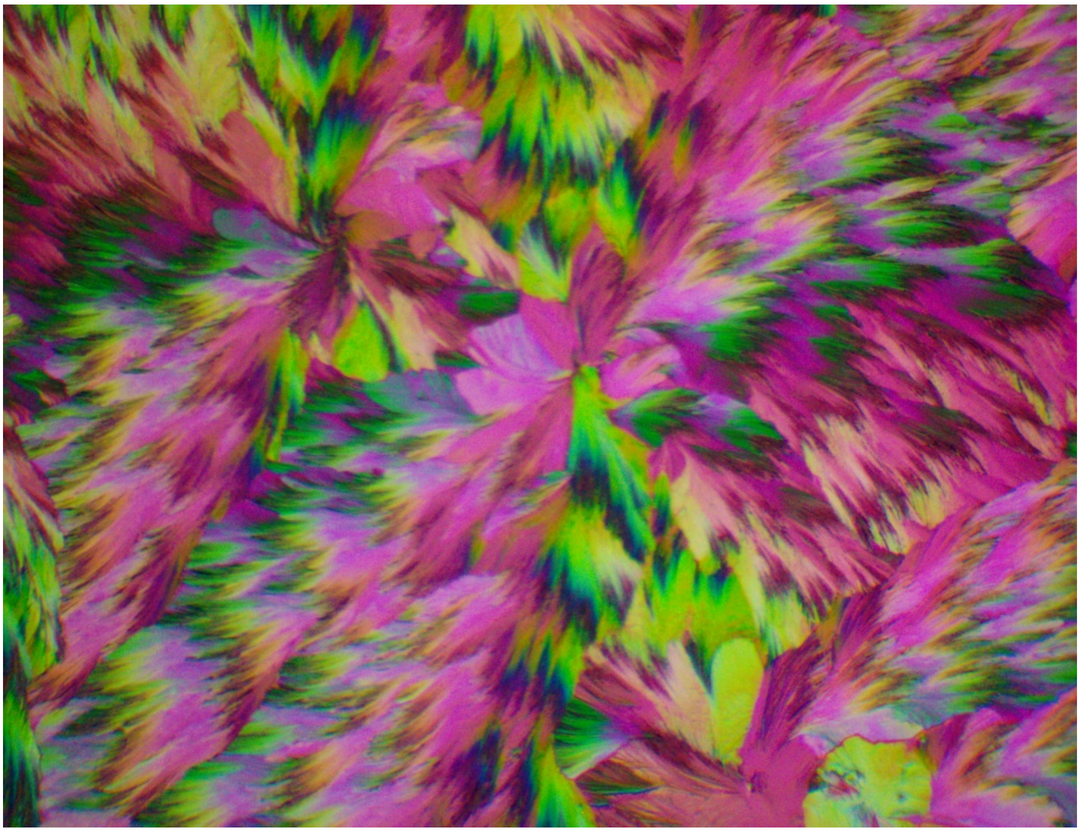
Specimen with retarder 6



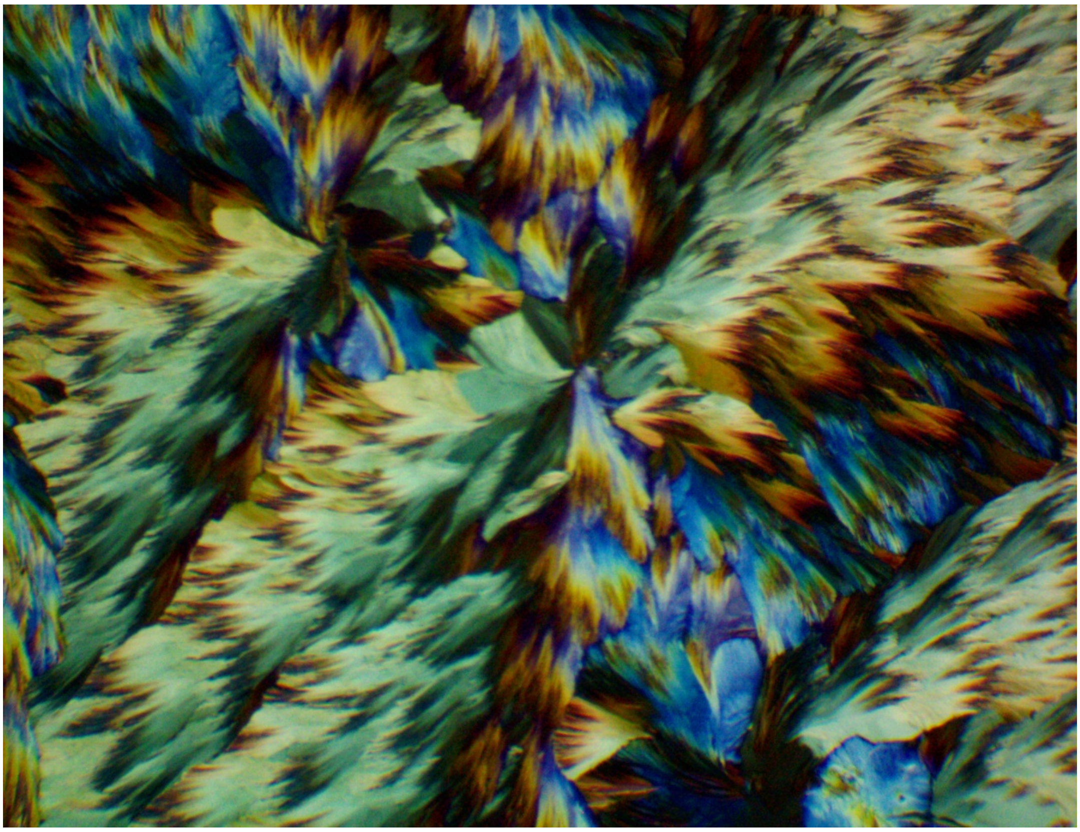
Specimen with retarder 7



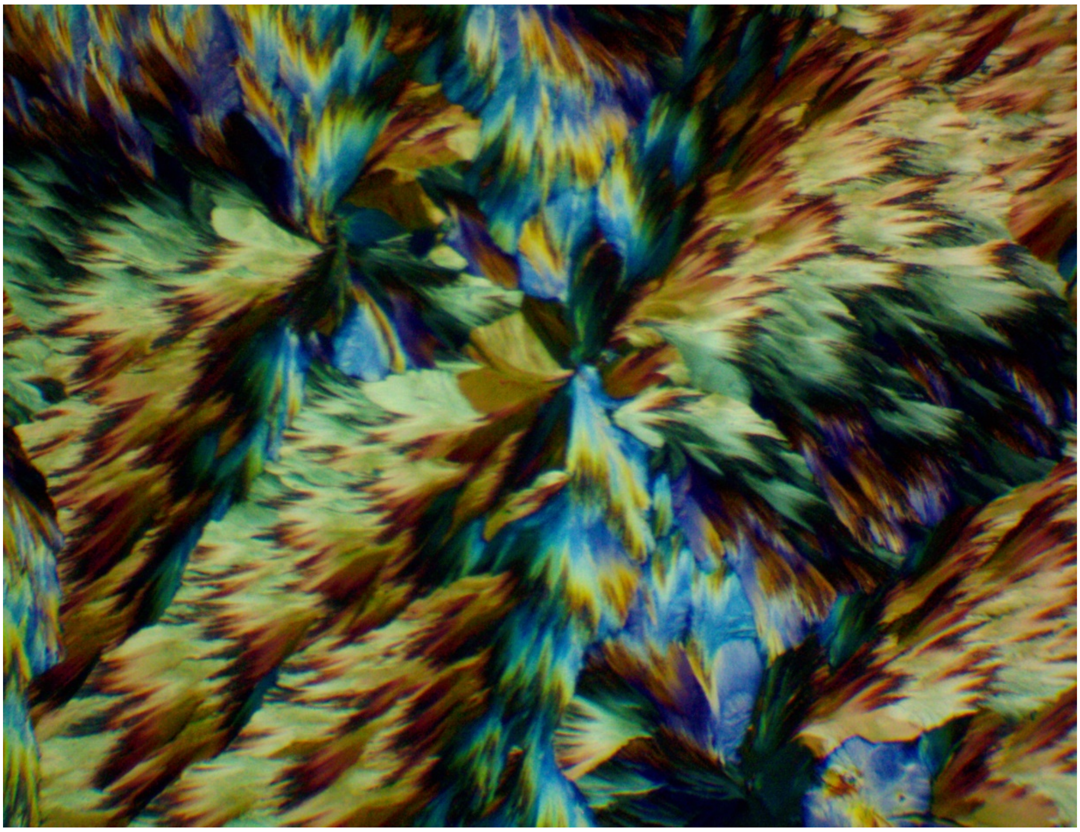
Specimen with retarder 8



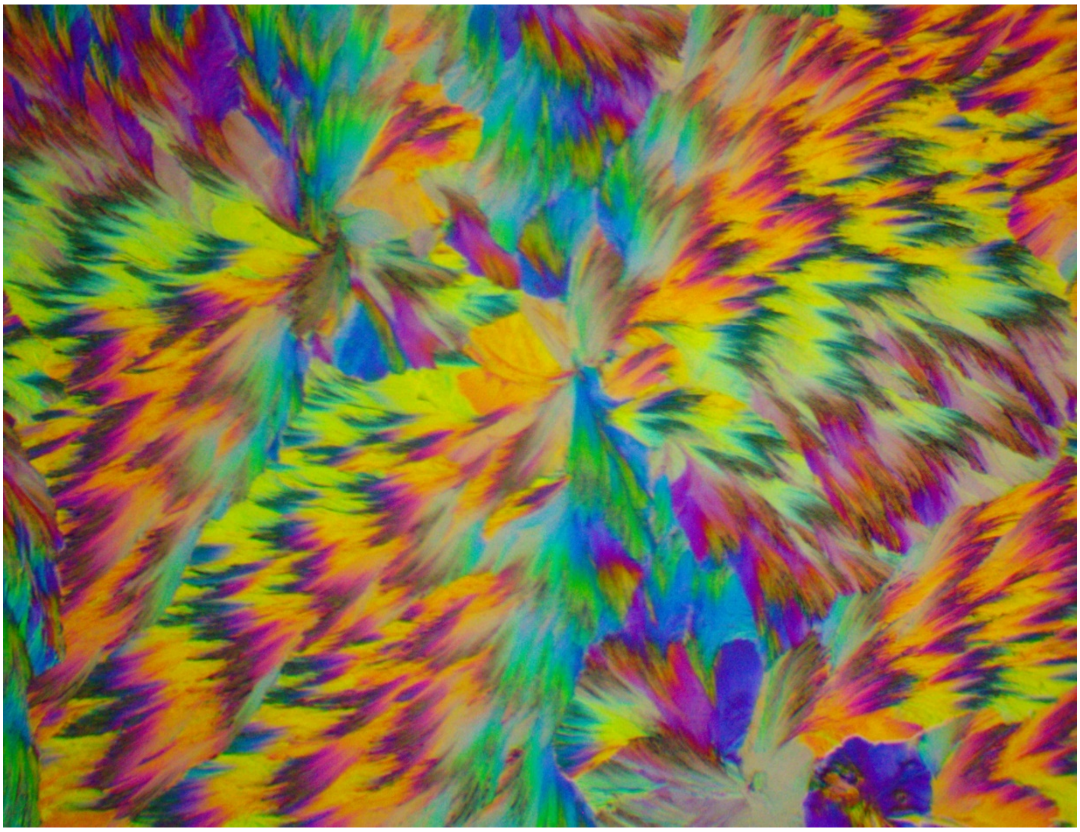
Specimen with retarder 9



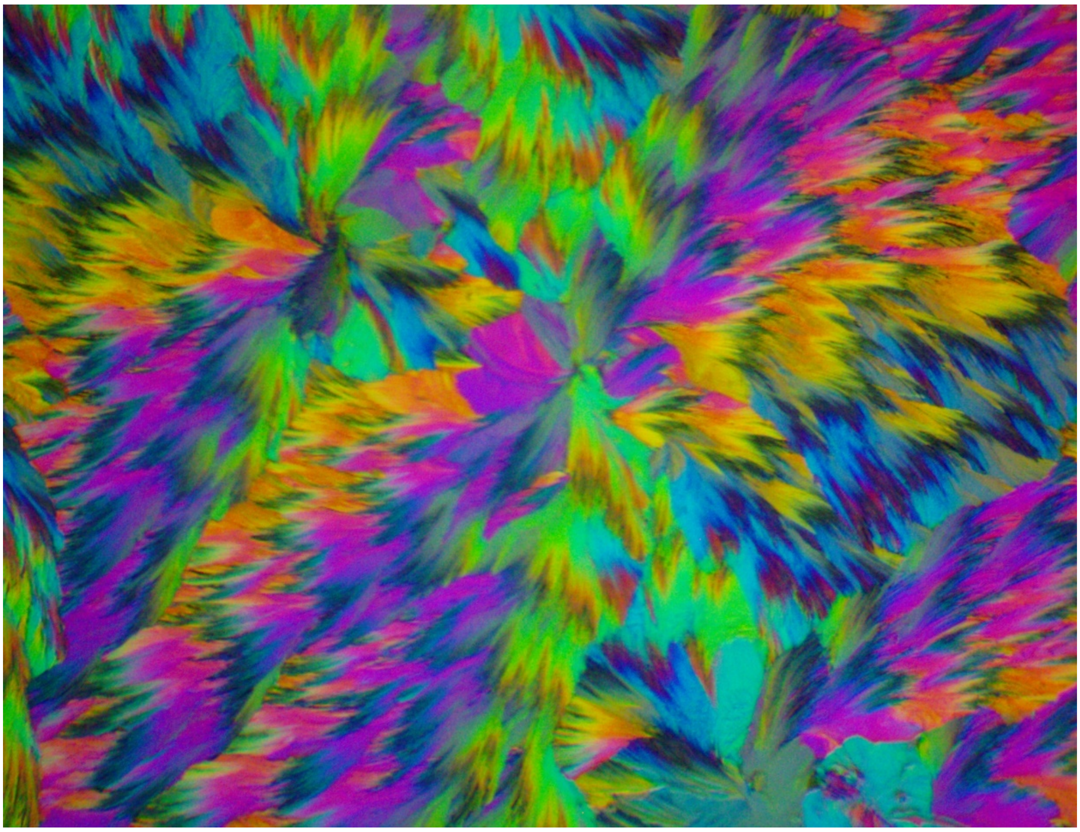
Specimen with retarder 10



Specimen with retarder 11



Specimen with retarder 12



Particular care was taken during the construction of the twelve retarders not to stretch the sticky tape further in any direction, which could have affected the orientation of the polymer chains within the polypropylene film and, thus, the birefringence of the sticky tape.

Microscopical Exploration 31 explores but a few of the possible combinations of total tape thickness and layer orientation available to the amateur microscopist in the construction of sticky tape optical retarders.

If You're interested…

As we say here in Cumbria:

'Ave a go yersel'!

Comments, gratefully received, to:

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