Tools for Materials Science - Challenge n°3 - 40'

PORTABLE MICROSCOPES

Thanks to new materials, optics is getting more and more robust, affordable, lightweight and …portable! Home microscopes will soon become a common and widespread tool, hopefully improving scientific literacy and inquiry based approach in education since childhood. On the other hand such instruments are incredibly powerful and particularly useful in underdeveloped areas enabling to run tests whenever and wherever you like even far away from research facilities.

On the desk you have a set of materials samples and different kinds of portable microscopes plus a USB one plugged to the PC. For each kind of sample you are expected to take pictures/videos and answer the related question. Answer should be connected to what is seen in the pictures.
When using the USB microscope you have to take a screenshot (the software DOES NOT allow you to save pictures) and then paste on a Word file (with its description) on the PC. You will use plexiglass double deck microscopes with your smartphone (either with or without the magnifying lens app) and save the pictures directly in the PC or send them by Whatsapp to your group –*See general instruction to share pictures or files*.
Q0. What's the **magnification** of both types of microscope? Can you give an estimation of it? (Suggestion: use the millimetre graph paper to calibrate.)

Sample n.1 – SAP (Super Absorbent Polymer) beads

Absorption rate is usually proportional to the absorbing surface area. In spite of this when you put a dry superabsorbent polymer bead into water, it grows much faster at the beginning when it is little. You will notice that in this first stage the shape is not really spherical.

Q1. Can you relate the surface particular structure to the super-absorption behaviour?

Sample n.2 – Gecko-tape

The gecko is famous for being able to run on vertical walls and even ceilings without falling**. Gecko-tape** is a man-made micro-structured adhesive tape made with a polymer and mimicking the real gecko foot, whose adhesion is due to the enormous contact surface between foot and wall achieved with a complex hierarchical nanostructure.

Q2. Can you guess the tape structure? [*In addition to microscope analysis you can also stare at it with a LED light (the smartphone flashlight will do) on the other side and moving the tape back and forth till you see something*. You may even test it with a LASER

Sample n.3 – Conductive textiles

The two conductive textile strips have a very different behaviour when stretched: in one of them the electrical resistance increases upon stretching, while the opposite happens with the second one.
Q3. Could this be related to the fiber knitting? Are they different?

Sample n.4 – Micro-optics sheets

Micro-optics plastic lenses are usually made with a basic repeated pattern. According to this pattern light may be bent in circles, in straight lines (similar to glass rods), diffused or concentrated. First take the sheets and observe a light bulb or your cell flash light looking through them. Note down the resulting effect.
Then observe with the microscope the same sheets and take snapshots trying to clearly identify the basic pattern (suggestion: move and rotate the sample). You may also try to study two layers one on top of the other while moving or rotating them. You will see images of rare beauty. Try to document them with your pictures.
Q4. Can you relate the overall light effect of the lenses to their structure?

Sample n.5 – Aeroclay

Q5. Aeroclay is a super-absorbing clay foam. Can you find any explanation of such property in their inner structure?

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☞**OUTPUT WANTED:** **meaningful pictures/videos of each sample with short description of what it is + related answer to the question on material specific properties**

Answer sheet **GROUP N°_____**

Ch.3 --- PORTABLE MICROSCOPES

Q0

Type of Microscope:		
Magnification:		

NB: *If you have (also) made a Word file with picture/description/answer in it, please save it on the PC and tell this to the teacher conducting the experiment; in this case you don't have to fill the answer sheet.*

Sample n.1

- **Picture1 description:**
- **Q1 answer:**

Sample n.2

- **Picture 2 description:**
- **Q2 answer:**

Sample n.3

- **Picture 3 description:**
- **Q3 answer:**

Sample n.4

- **Picture 4 description:**
- **Q4 answer:**

Sample n.5

- **Picture 5 description:**
- **Q5 answer:**

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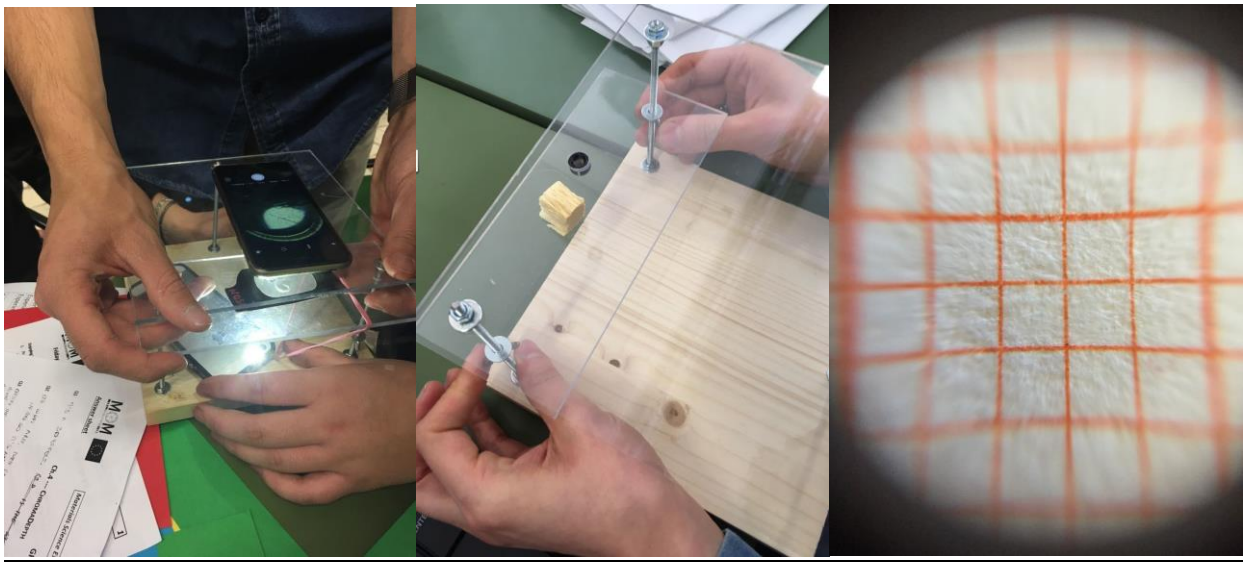
Teacher's notes

Technical notes:



You can use millimiter paper to calibrate by a proportion. See however the distorted image at the boundaries It's fundamental to have the proper light from the bottom. You can regulate the focus by gently turning the screws. The smartphone lens is aligned with the microscope lens. You may also think to enhance the whole system by using one of the many "magnifying lens" app available online.

Organizational notes:

- Each student will keep a copy of the students' sheet but the group will collectively fill in the answer sheet and give it over to the teacher in charge at the end of the lab.
- Teacher conducting the experiment should remember to remove the file (or directory), if present, with the pictures/descriptions/answers inside before next group will use the PC

Correction grid

Question or Request	Note	Max. score
Q0	Good agreement with data below	2
Sample n.1	• Is picture* meaningful ? (Yes/No: 1 point) • Is picture* beautiful ? (Yes/No: 1 point) • Is the answer connected to and motivated by what the pictures show (DO NOT care if the answer is "correct" or not)? (Yes/No: 1 point)	3
Sample n.2		3
Sample n.3		3
Sample n.4		3
Sample n.5		3
Extra point	Give 1 more point for each answer which is (more or less) "correct" – see the key below	3

***Pictures**: are the pictures meaningful? [*To evaluate the "meaningful" see also the "Picture Description" on the Answer Sheet*] Are they focusing on significant details or clearly showing the apparatus structure or the investigation results? Are they aesthetically beautiful?

Key to Answer

Q0 For the USB microscope the magnification power depends also on the distance between the sample and the lens of the microscope; for the portable microscope the magnification depend also on the zoom of the smartphone used. Typical values of the magnification are 40X for the portable microscope and 60X for the USB ones.

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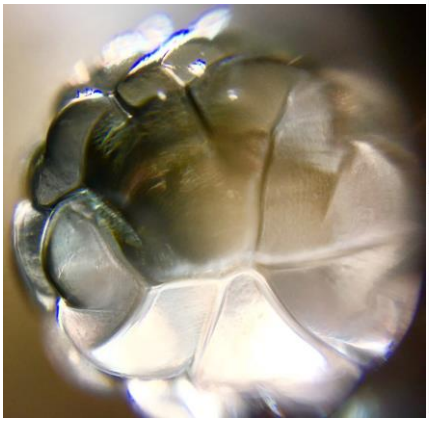
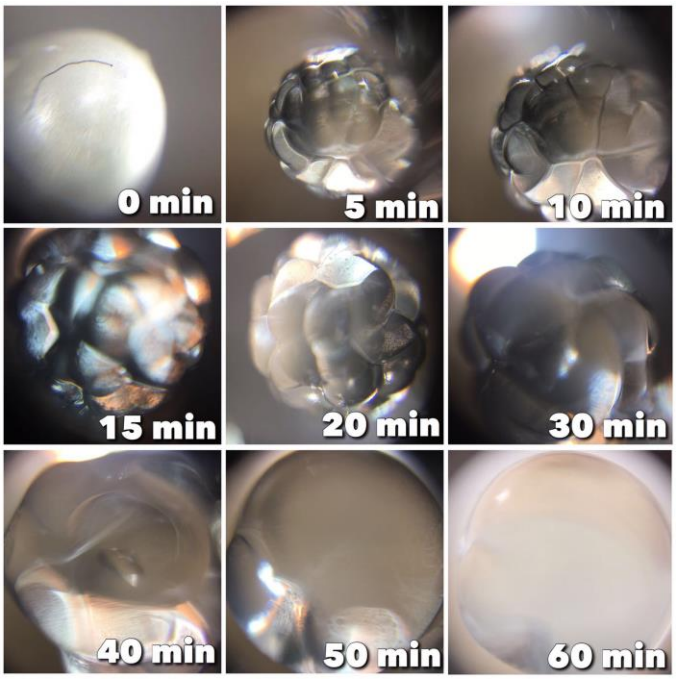
Q1 --- Q5 This is an observational experiment with new and "strange" material, so we don't have (at least not for all the sample/question and/or not exactly) the "right" answer! Just assume a researching attitude and see if the answer well fits (from a physical point of view) with the short introductive description given for each sample. Below some more indication, for each sample, if present. The following images have been taken by a student using the microscope.

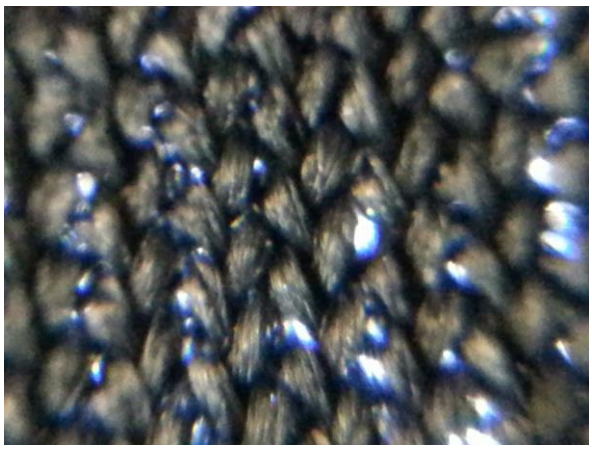
Q1 SAP For further details and quantitative data on the polymer growth and applications see the module ***Superabsorption polymer and foams***.To summarize it briefly the absorption rate is quite fast at the beginning and then progressively decreases. This is ultimately due to the fact that the absorbing surface is much larger with all its folds and creases at the beginning.

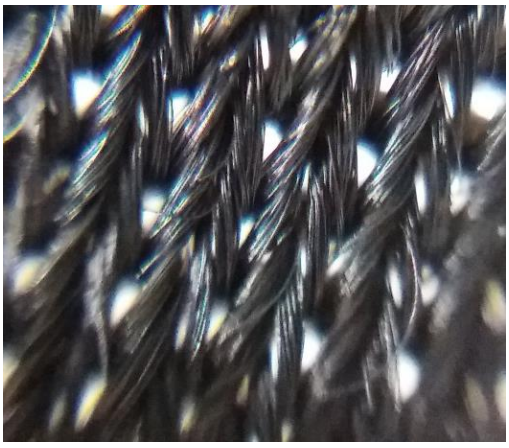




Q2 GECKO TAPE array of exagonal pillars. Shining light a diffraction effect is clearly visible moving back and forth in front of your eyes.

Q3 CONDUCTIVE TEXTILES- The knitting is definitively different therefore impacting on the variable resistance due to stretching. Left: resistance decreases; right: increases





Q4 MICRO OPTICS SHEET

The unusual effect of the circle produced by the light of a single LED or lamp is caused by the conic arrays of the microoptic sample which are bending the light along a circular arc. Cones are quite visible in the detail. The beautiful artistic photo below has been produced by superimposing and then rotating two microoptics sheets.

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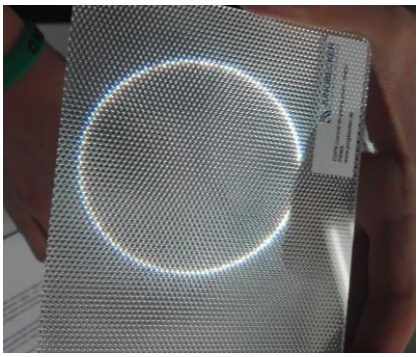
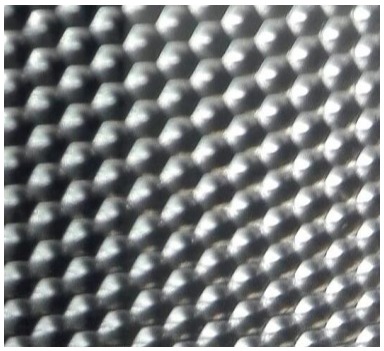
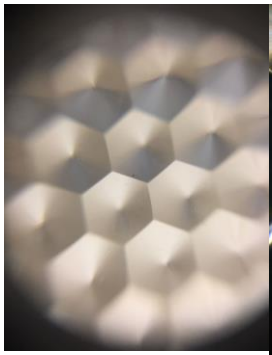
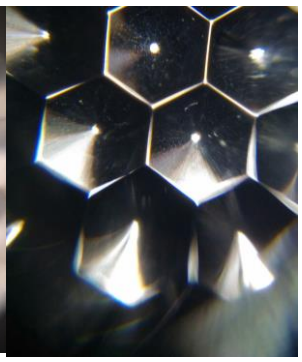
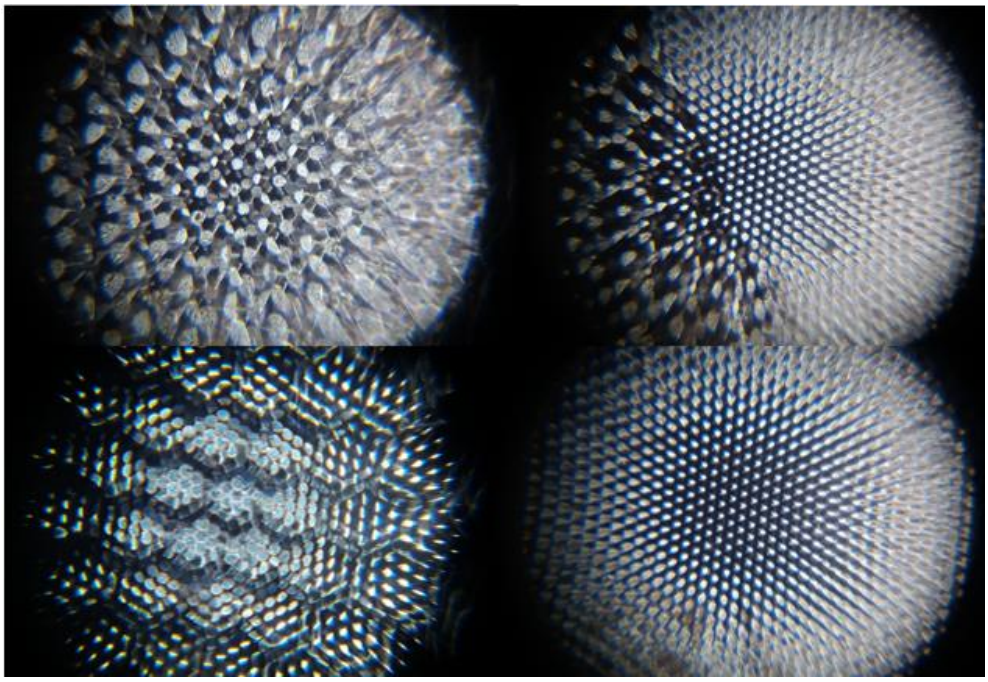
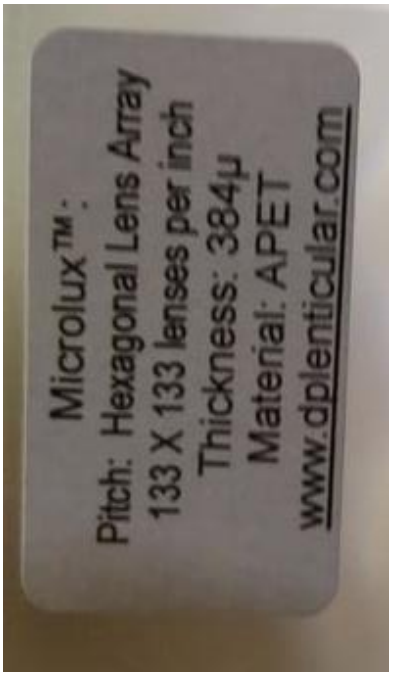
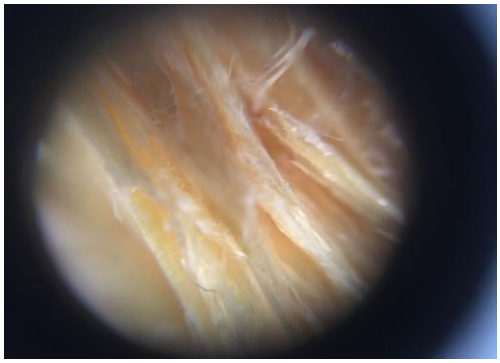
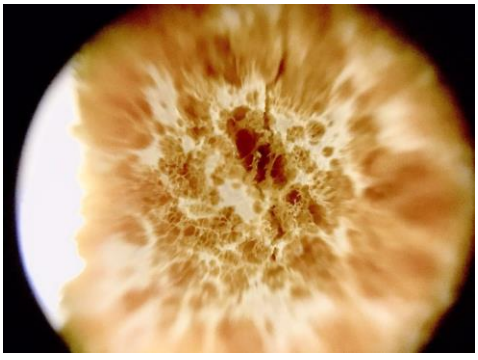







Q5 AEROCLAY – The superabsorbing power (see also the module **Superabsorbers: polymers and foams**) is


due to the long fibers and huge number of cavities like in a sponge. The student set the aeroclay and a sponge side by side to highlight the similarity.

Following, although not featured in the students' sheet samples of EMR shielding textiles. From the microscope view it's quite clear that they have woven very differently and it's possible to calculate from the picture the grating dimension.

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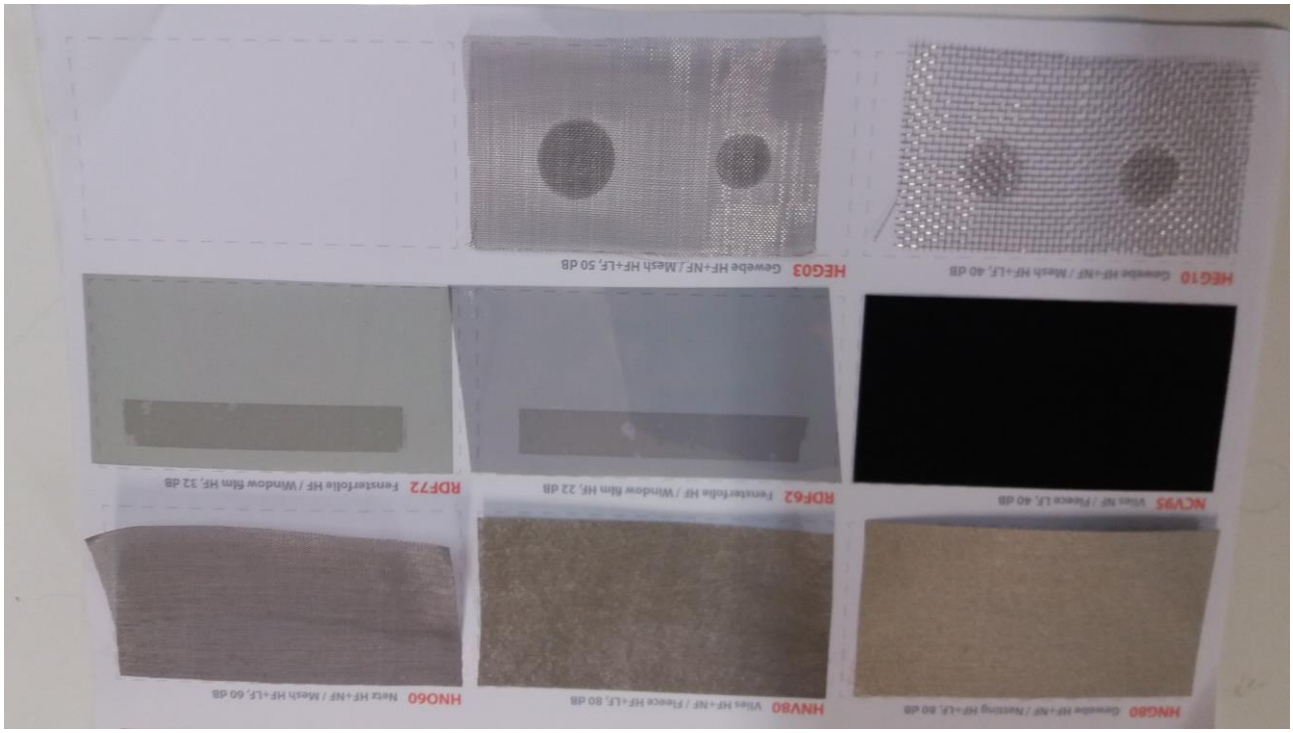

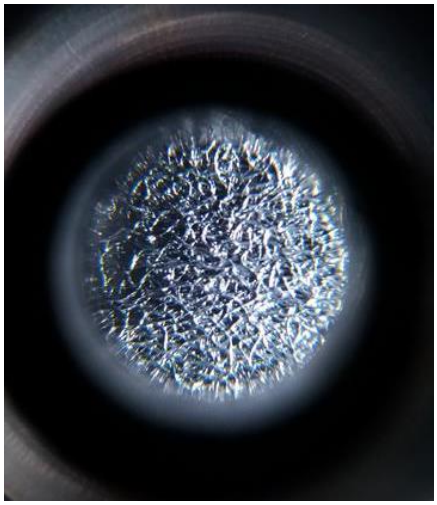

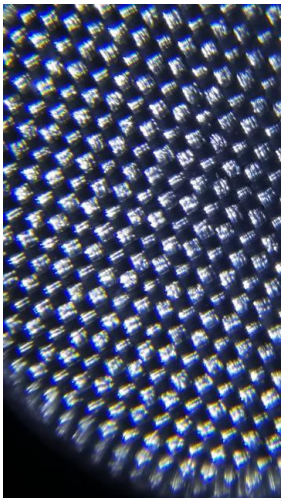

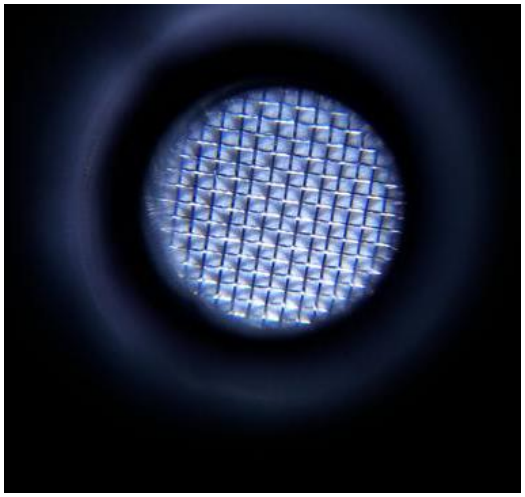

MoM Resources (http://www.mattersofmatter.eu/mom-materials/)

- **Microoptics PPT**
- **Water wars PPT** and the module ***Superabsorption polymer and foams*** (for SAP)
- **Ch3_TEACH_EN_Unusual_conductive materials** (for the conductive textiles)

References

- Building instructions http://www.instructables.com/id/10-Smartphone-to-digital-microscope-conversion/

Where to buy

- Microscope lens http://www.aixiz.com/ approx. 1 euro for each lens + shipping (10 euros), a possible alternative at zero cost is to recycle the lens of a laser pointer
- Gecko tape http://www.utilineashop.it/ 43.5 euros per meter + shipping
- SAP (on Amazon or at florists')
- MicroOptics sheets: Jungbecker e dplenticular (see acknowledgments)

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- Conductive textiles plugandwear www.plugandwear.com
  mindsetsonline https://mindsetsonline.co.uk/
- Aeroclay: Aeroclay Inc see https://youtu.be/o11KP9xF5SA
- EMR shielding textiles Yshield www.yshield.eu/.com

Acknowledgments for offering samples

- Jungbecker http://www.jungbecker.de/en/optik/
- Dplenticular www.dplenticular.com
- AeroclayInc
- Yshield www.yshield.eu/.com

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