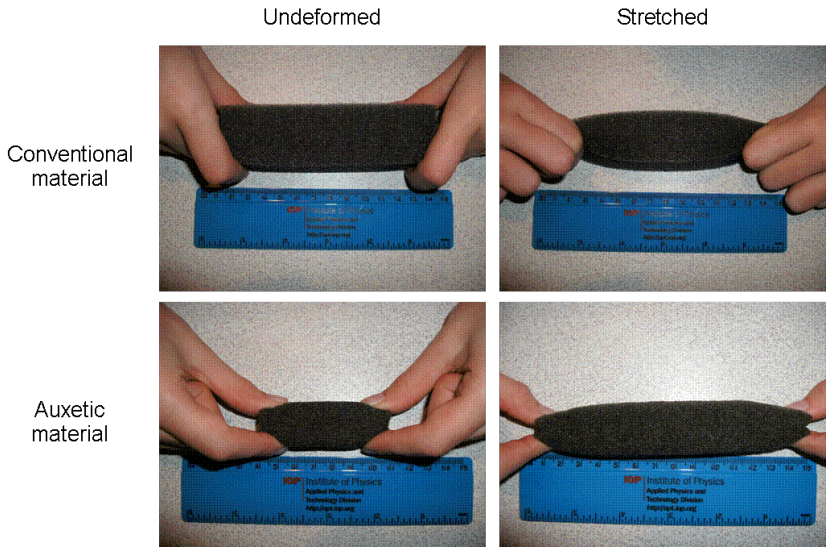
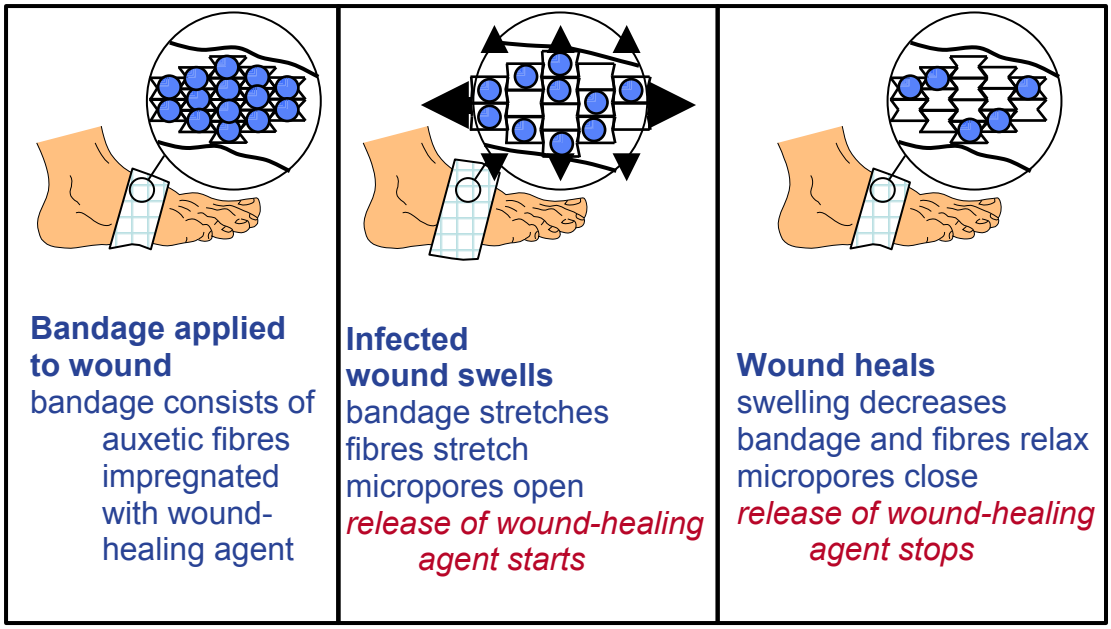
NEGATIVE MATERIALS

Kim Alderson

Most materials get thinner when they are stretched, but there are materials that do not! Cork stays exactly the same and this is why it can be used in the neck of a wine bottle. It has a zero Poisson's ratio. The materials I work with get fatter when you stretch them. They have a negative Poisson's ratio and are called "auxetic" materials.



These can be used as seals but there are many possible other uses. For example, imagine a textile that expands as you grow. The materials work by opening of pores so if the pores were to be filled with wound healing agents, then when the wound is swollen, the material will expand and the pores open, releasing the wound healing agent. Just as soon as the swelling goes down, the pores will close and the wound healing agent which is no longer needed is no longer released.



A further area which is being looked at for these materials is linked to their ability to absorb energy and sound. So, they could be used for personal protection (eg in sportswear like batting gloves and shin pads). Tests have also shown that they are better at resisting wear too. Finally, there are natural materials that expand when stretched. These include certain types of bone and skin so by creating synthetic matches to these, then it should increase the chances of successful medical devices.

There are other materials which display negative, or opposite to usual, properties. These include negative refractive index materials. This idea can be explained by looking at the picture below. On the left, the spoon in the water appears broken just at the point where the air and water meet. This is due to the refractive index of the air and water being slightly different, but still positive in both cases. However, the picture on the right shows what would happen if the water had a negative refractive index. The spoon is bent in the opposite way, effectively, because negative refractive index materials bend the light in the opposite direction. These materials are being developed for cloaking and invisibility.

Negative stiffness materials get smaller when you pull them, rather than getting larger, and negative thermal expansion materials contract when you heat them and expand when they are cooled.

All these materials are being researched currently, and you will be able to think of uses for these which could have a significant impact on Future Manchester. Combining the sets of properties could produce smart reactive materials. So, you could have a textile that was made from negative refractive index materials and also expanded when you put it on, was resistant to wear and absorbed sound. Or you might think of a protective garment with its own in-built supply of wound healing agent to be released as, when and where needed.

You might also want to think about other negative materials which could transform the way the world works. Which other properties than stiffness, bending of light and thermal expansion could, effectively, be reversed and what effect would this have on Future Manchester?

Over to you!

About Kim Alderson

Kim Alderson received her BSc (Honours) in physics with materials science in 1986 and her Doctorate in 1990 from the University of Liverpool, UK. She has published over 60 peer reviewed papers and is co-inventor on 16 patent applications. She held a Lectureship at the University of Liverpool before taking up a Research Fellowship at the University of Bolton in 1995. She is a member of the EPSRC peer review college. She was the ‘Materials and Mechanisms’ theme leader at the ‘Celebration of UK Engineering Research & Innovation’, London 2004. She was a Finalist in the British Female Inventor of the Year awards (2002). She was Principal Investigator of the Auxetic Materials Network. Kim is the co-organiser of the University of Bolton events for the Manchester Science Festival and is a member of the Festival Partners Group.