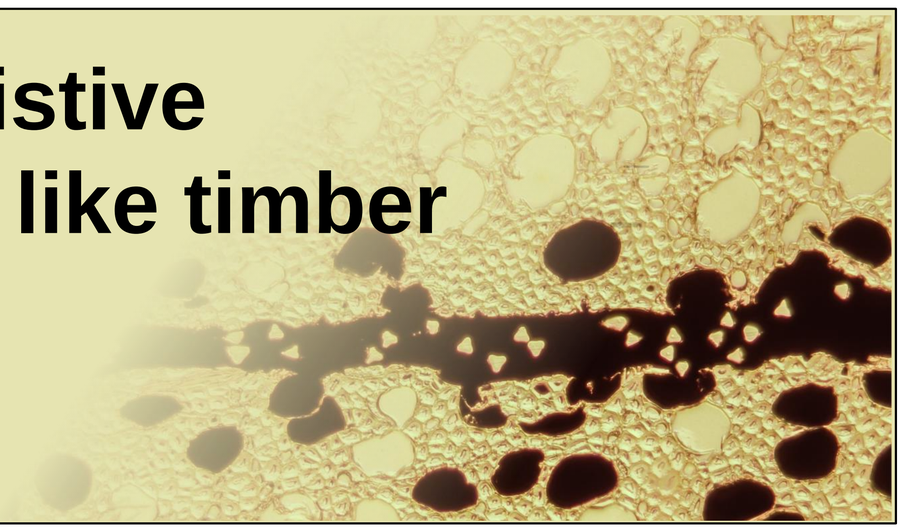
Challenges for the use of piezoresistive adhesives in anisotropic materials like timber



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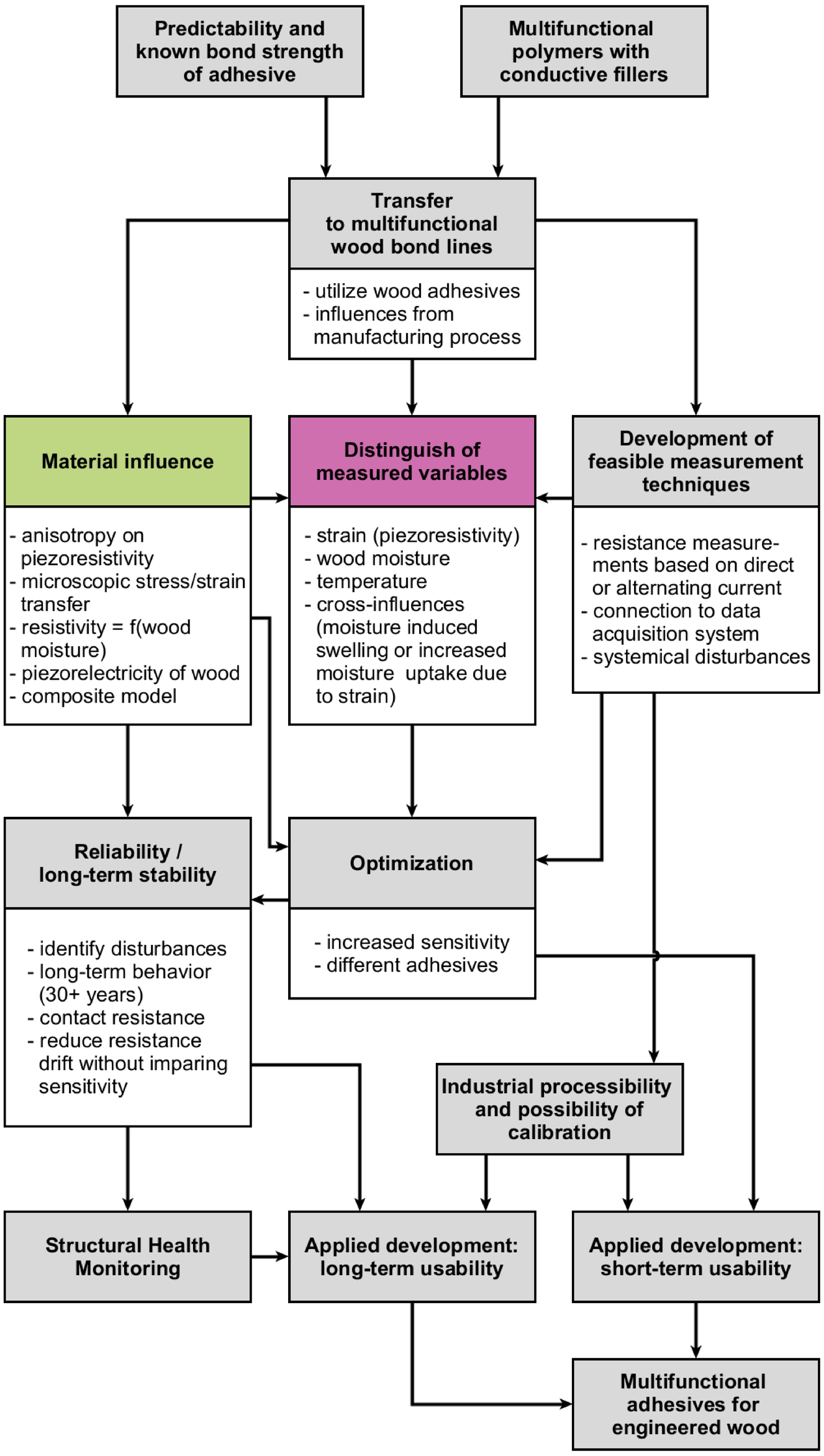
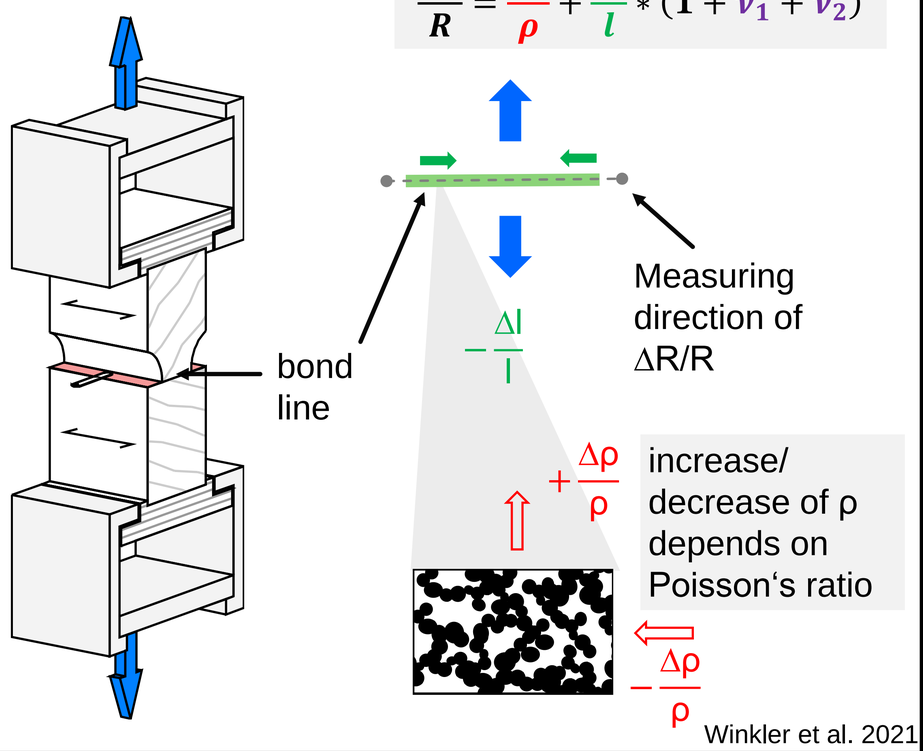
In the last years, the concept of multifunctional polymers by addition of electrically conductive filler was applied to adhesives for engineered wood. These multifunctional adhesives (usable as sensor and bonding wood) open a new horizon for wood engineering. Public buildings as schools, multi-storey buildings, large span halls and bridges consisting of wood based materials have to be assessed regularly. Integrated sensing layers are providing the possibility to monitor the structure with regarding high stress or elevated moisture content.
From the early stage research, new challenges and research questions emerged for the application of piezoresistive adhesives in anisotropic and moisture-sensitive materials under structural conditions. The topics for research are structured in the following overview.



Influence of anisotropy

Fractional change of resistance results from fractional change in resistivity and measuring length. Differences in Poisson‘s ratio of the stress transferring wood can result in differences of piezoresistive sensitivity by changes in resistivity of the bond line.

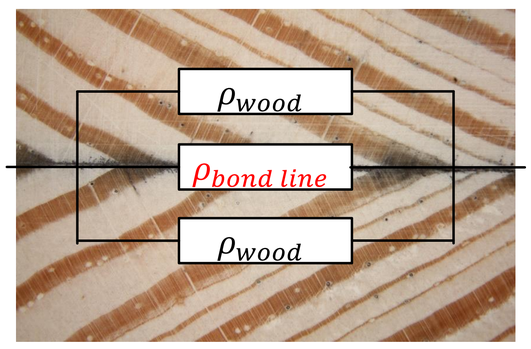
$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \frac{\Delta l}{l} * (1 + \nu_1 + \nu_2)$$



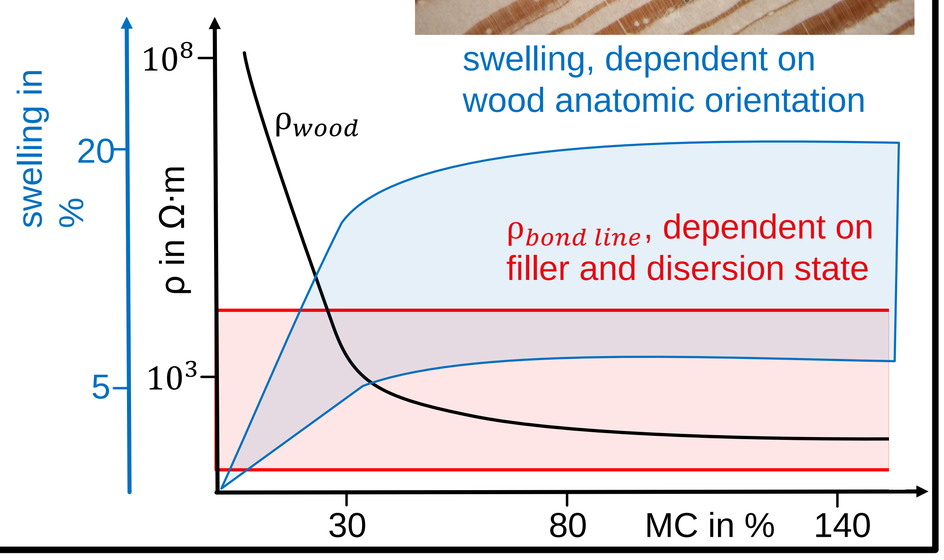
Winkler et al. 2021

Moisture/strain relation

Piezoresistive measurements in the bond line are influenced by the resistivity of the parallel resistor wood as well as the swelling of wood with increasing moisture content (MC). Piezoresistance of the bond line is only utilizable, if the two measured variables can be distiguished.



swelling, dependent on wood anatomic orientation



References:
Winkler C, Haase S, Schwarz U et al. (2021) Piezoresistive bond lines for timber construction monitoring—experimental scale-up. Wood Sci Technol 55:1379–1400

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