

## Understanding liquid transport in innovative 3D formed cellulose-based packaging using MRI

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**Introduction:** Driven by the global shift toward circularity and sustainable resource management, the packaging industry (for e.g. food, cosmetics, ...etc) is being redefined through the development of innovative 3D fiber-based packaging made from waste and recycled materials. As single-use plastics continue to pose a major environmental threat, there is an increasing demand for renewable, recyclable alternatives that offer comparable performance. Among these innovations is the dry-formed cellulose packaging technology [1] capable of replacing plastic at scale. In this process, fluff cellulose pulp is fed into a mill where it is separated into individual fibers and combined with functional additives. The fibers are then airlaid into dry pads, which are shaped into thin, rigid products through a heat and pressure-based deep-drawing step, followed by trimming and finishing. This method significantly reduces water usage and yields high-rigidity packaging that outperforms traditional wet-moulded fiber products. To further optimize this process and improve the product performance, in-depth material characterization is essential. Our work focuses on using MRI to investigate liquid transport within these fiber-based materials.

**Methodology:** A MRI method has been developed and applied to monitor water ingress in flat packaging surfaces [2]. For complex packaging geometries, a specific MRI instrumentation is required. As part of our research, we are designing a miniature radiofrequency (RF) coil adapted to the shape of the packaging and placed near the region of interest to enable localized measurements of liquid transport. By minimizing the coil's dimensions, we increase the filling factor, which enhances the signal-to-noise ratio (SNR) and significantly improves the sensitivity of the MRI analysis.

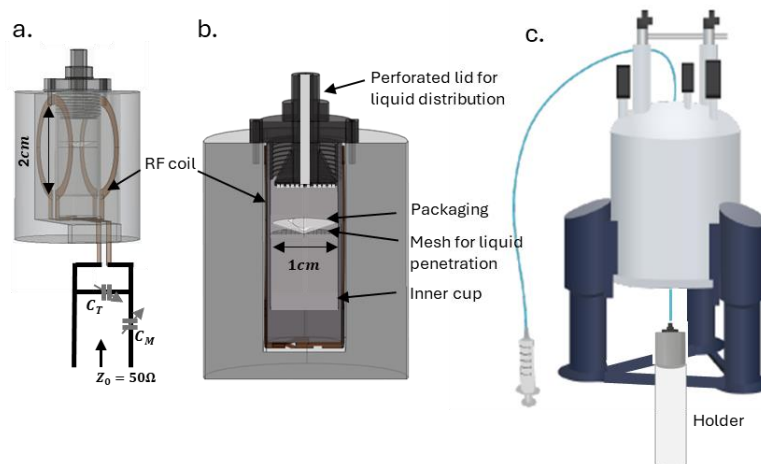


Figure: MRI setup. (a) The RF coil and its electronic circuit. (b) A cross section of the setup. (c) Implementation of the setup in the MRI magnet.

**Conclusion:** We believe that this advanced analytical approach will provide deeper insights into liquid transport within complex 3D materials, advancing dry forming technology to produce higher-performance, innovative and sustainable packaging. This will establish a solid foundation for scalable, circular solutions that support the transition to a more sustainable, biobased economy.

**References:** [1]. Dry Forming Process. <https://www.yangi.se/the-process>. [2]. M. ÅKESSON. Master's thesis in Materials Engineering. Chalmers Univ of Tech