

Microwave Food Processing Applications at RISE

Birgitta Wäppling Raaholt

RISE Agrifood and Bioscience, Göteborg, Sweden

RISE Agrifood and Bioscience (formerly SIK – The Swedish Institute for Food and Biotechnology) is part of Research Institutes of Sweden (RISE). One purpose of the institute is to strengthen the competitiveness of industry. RISE has about 2200 employees, most of whom are university graduates. About 150 employees work at Agrifood and Bioscience covering all fields of food science and technology as well as agriculture, with main office in Gothenburg, and with regional offices throughout Sweden.

The research group for Process and Technology Development is well recognized in the microwave and infrared processing and measurement areas, with Dr. Birgitta Raaholt as the area leader since several years. RISE has a long-standing experience with pioneering work already in the late 1950's in the area of microwave processing applications for food industry (e.g. Ohlsson and Bengtsson, 2001), covering different kinds of industrial food applications (Wäppling Raaholt et al, 2013; Wäppling Raaholt, 2015), e.g. controlled microwave heating (Wäppling Raaholt and Isaksson, 2017; Wäppling Raaholt et al, 2002; Wäppling Raaholt and Ohlsson, 2009 and 2005), pasteurisation (Wäppling Raaholt et al, 2016), sterilisation (Figure 1), baking (e.g. Wäppling Raaholt and Waldén, 2011), drying (e.g. Malafronte et al, 2012), volume expansion, tempering, combined microwave processes (e.g. microwave-infrared baking and drying, microwave-convective processing, microwave impingement processing, etc.), different means for process intensification, tools for microwave modelling and optimization of process designs as well as product-related concepts intended for the microwave oven (Wäppling Raaholt, 2000; Wäppling Raaholt and Ohlsson, 2000), feasibility studies regarding choice of technology and up-scaling, as well as microwave measurement

technology (e.g. Wäppling Raaholt and Risman, 2003, Dalvi-Isfahan et al., 2017). The group develops research and innovation concepts for innovative microwave food processing, methods and technologies for microwave processing applications of all kinds applicable to the food and packaging industry area, including different methods for characterizing dielectric properties of foods, methodologies for process validation using fiber-optic probes, time-temperature indicators, infrared cameras, and much more. Furthermore, the group has extensive experience in microwave processing of particulate food systems regarding heating uniformity (slurry and particulate), predictive modelling of heat process scenarios in terms of microbiological inactivation as well as effects on product quality (texture, color, piece integrity, etc.).

Among examples of research activities of the group are: industrial applications of microwave processing, e.g. continuous tubular in-flow microwave processing of foods for sterilization as well as pasteurization, combined microwave baking and drying technologies, microwave-assisted drying and puffing applications, microwave tempering of frozen foods, design of microwavable foods and packages, but also feasibility studies regarding choice of technology, technical decision criteria, and scenarios for up-scaling. Other activities of the group include microwave process design and implementation of microwave processing units, design of microwavable foods and packages, microwave decontamination of food waste and soil, etc.

Moreover, RISE has long-standing expertise in applications where microwaves are combined with other technologies for several types of applications, as well as in comparative studies between food processing technologies, e.g. evaluation of advantages and draw-backs of one

innovative food processing technology compared to a conventional or alternative technology. RISE also has research projects on freezing of foods using a highly innovative technique combining freezing at slow rate with part time emission of microwaves (2,450 MHz).

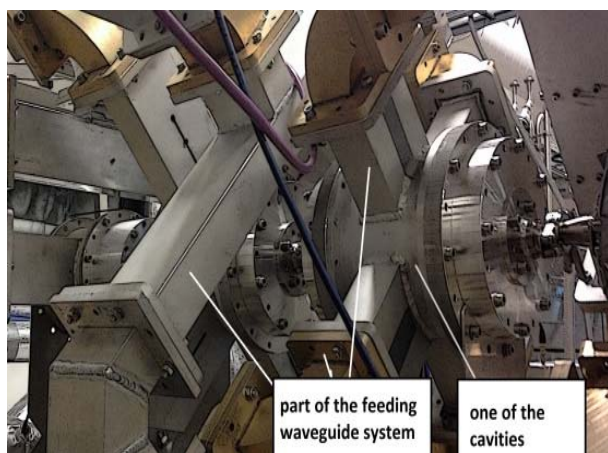


Figure 1. Example of microwave process systems developed at RISE.

RISE's expertise includes several areas in the microwave processing area, such as design of microwave process systems, microwave

modelling, simulation and optimization, process evaluation and validation, feasibility studies as a basis for technical decision criteria, implementation as well as partnership for successful up-scaling and industrialization. RISE specifically performs research and develops innovative microwave processing methods for food processing for both academic research and confidential contract R&D.

RISE also has a strong competence within other processing technologies, such as infrared applications, RF processing, pulsed electric field (PEF) processing, ohmic processing, etc., as well as quality characterization. The latter includes macroscopic as well as microscopic methods. Additionally, the expertise also includes unique competences within biogas processing, waste water treatment, etc.

Furthermore, RISE Agrifood and Bioscience also has unique facilities for mechanical and rheological analyses, and is one of the leading European laboratories for experimental rheology. An ultrasonic velocimetry profiling/pressure difference system (UVP-PD) has been developed for in-line determination of fluid rheological properties, and could be combined also with microwave in-flow processing. Ultrasonic pulses are used to non-invasively measure rheological properties in real time. The UVP-PD can monitor opaque fluids and the UVP has a resolution down to micrometers.

When it comes to microstructural analysis, instrumentation and experience includes all types of microscopy ranging from light to electron microscopy (TEM, SEM, ESEM) including Confocal Laser Scanning Microscopy (CLSM). The samples are prepared by plastic embedding, cryo-sectioning or cryo-techniques such as freeze-etching. The laboratory for olfactometry analysis is well equipped with instruments for liquid and gas analyses with gas chromatography. Standard equipment as ATD, SPME- liquid- and headspace-autosampler are used in combination with olfactometry and FID-/MS-detectors. RISE Agrifood and Bioscience also has a long standing experience in characterization of biopolymer systems such as particles, films, coatings and

foams based on proteins, in release applications, and in national and international projects. These projects have been financed by e.g. the Swedish National Research Agency FORMAS, The Swedish Technical Board Vinnova, the Swedish Energy Agency, EU, and the Swedish Board of Agriculture. Furthermore, the group has extensive experience in whey proteins regarding interactions between the protein matrices and charged solutes and the resulting diffusion properties measured by FRAP and binding, phase separation kinetics, gelation in restricted geometries and interaction with aroma compounds.

RISE is a leading, independent international research institute, offering core competence within e.g. food technology and a large number of applications of microwave processing of foods, microwave engineering applied on food applications, determination of dielectric properties, infrared processing, PEF and conventional processing, as well as a wide spectrum of research and innovation services and cross-border business areas for industry partners, SMEs, academia and the public sector. RISE has long experience and extensive know-how and expertise from interdisciplinary research projects, focusing on research & innovation as well as sustainable development. Through global cooperation, RISE contributes to industrial development and value-added research & innovation to promote competitiveness and sustainable development.

For further reading:

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About the Author



Dr. Birgitta Wäppling Raaholt, affiliated with RISE Research Institutes of Sweden, is the area leader of Advanced Thermal Processing, including the Microwave/RF and Infrared (IR) Processing of Foods at RISE Agrifood and Bioscience. Birgitta holds a PhD degree in Electromagnetics and Microwave Processing and has an

educational background including a Licentiate of Engineering degree in Microwave Technology and Electromagnetics, and an M.Sc. degree in Engineering Physics from the Chalmers University of Technology, Gothenburg, Sweden. She has extensive work experience in international industrial and academic projects. Her research interests are within e.g. applications of electromagnetics, combined microwave-convective-IR processing of high-quality foods, microwave and IR process intensification, modelling, design and optimization of microwave heating

processes as well as dielectric measurement methodologies. Other research interests involve food processing technologies and sustainable food production systems. She has worked for more than 20 years in the development of innovative technologies for microwave processing of foods for a wide range of applications as well as for other types of food applications. Dr. Raaholt is a member of professional associations, including the Association for Microwave Power, Education and Research in Europe (AMPERE) and the Microwave Road www.microwaveroad.se.

RISE Agrifood and Bioscience, formerly known as SIK – the Swedish Institute for Food and Biotechnology, is located in Gothenburg, Sweden (RISE Agrifood and Bioscience, Box 5401, SE-402 29 GÖTEBORG, SWEDEN).

For more information:

https://www.researchgate.net/profile/Birgitta_Raaholt

E-mail: Birgitta.Raaholt@ri.se