DIELECTRIC MONITORING OF THE PAN FIBER STABILIZATION PROCESS

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Carbon fiber composites are key components of future lightweight applications. But, due to the energy intensive production of carbon fibers, the final material costs are not competitive if compared to steel or aluminum even though the mechanical properties are superior [1]. Hence, a new approach is necessary. Microwave heating might be the solution [2]. For the successful design of an appropriate system, the knowledge of the temperature-dependent dielectric properties of the raw material together with the chemical process during the production is mandatory. The production process starts from the Polyacrylonitrile fiber (PAN fiber) and consists of two major stages: the initial stabilization and the final carbonization. The most significant energy saving is expected at the stabilization stage [3].

The dielectric properties of conventionally stabilized PAN fibers and virgin PAN fibers were measured at room temperature in a TM_{010}-mode cylindrical cavity using the cavity perturbation method. The measured differences in the dielectric constants and the material densities of both fibers (see Table 1) leads to the assumption that the change in the dielectric properties can be followed during the stabilization process and allows controlling the chemical reaction. Currently a system is set up that enables the in-situ recording of the chemical reaction during the stabilization process by using conventional heating. Figure 1 shows the schematic of the setup. The PAN fibers are located in a quartz tube. The conventional heating bases on the controlled flow of hot air. Thermocouples measure the temperatures at the entry and the exit points of the hot air. It is expected that the data acquired from the measurements will provide useful information about the reaction kinetics, which is important for the design of a microwave assisted stabilization process.

Table 1. Comparison of the properties of virgin and stabilized PAN fibers

	Virgin PAN Fiber	Stabilized PAN Fiber
Density [g/cm^3]	1,14	1,38
ε_r'	3,78	7,89
ε_r''	0,004	0,065

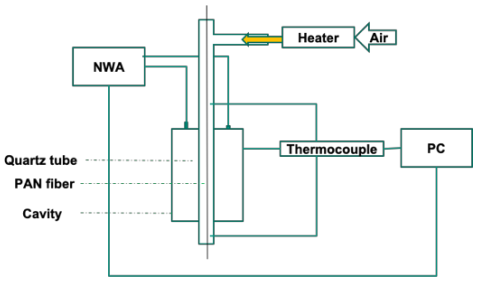

Figure 1. Measurement System Setup

References

1. Frank, E., et al., *Angew. Chem. Int. Ed.*, 2014, vol. 53, 5262-5298.
2. Papargyris, et al., *Composites Science and Technology.*2008, vol. 68, 1854-1861.
3. Liddell, H. et al. *Bandwidth Study on Energy Use and Potential Energy Saving Opportunities in U.S. Carbon Fiber Reinforced Polymer Manufacturing.* 2017.