The Memory Effect in Polyolefinic Products:
A Tool for Confirming the Steam-Sterilization Process?

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In our studies of medical polymer products that were steam sterilized, we noticed a distinctive feature in DSC measurements. Upon the first heating in DSC experiments, the formation of an endothermic peak or step, known as the memory effect, was observed around 110-120°C. After the first DSC heating the materials were cooled down and heated up a second time. During the second heating no signal between the previous temperatures could be observed any longer. An example is shown for sterilized and non-sterilized ampoules (PE) in Figure 1.The observed phenomenon could be used to provide evidence for steam sterilization.

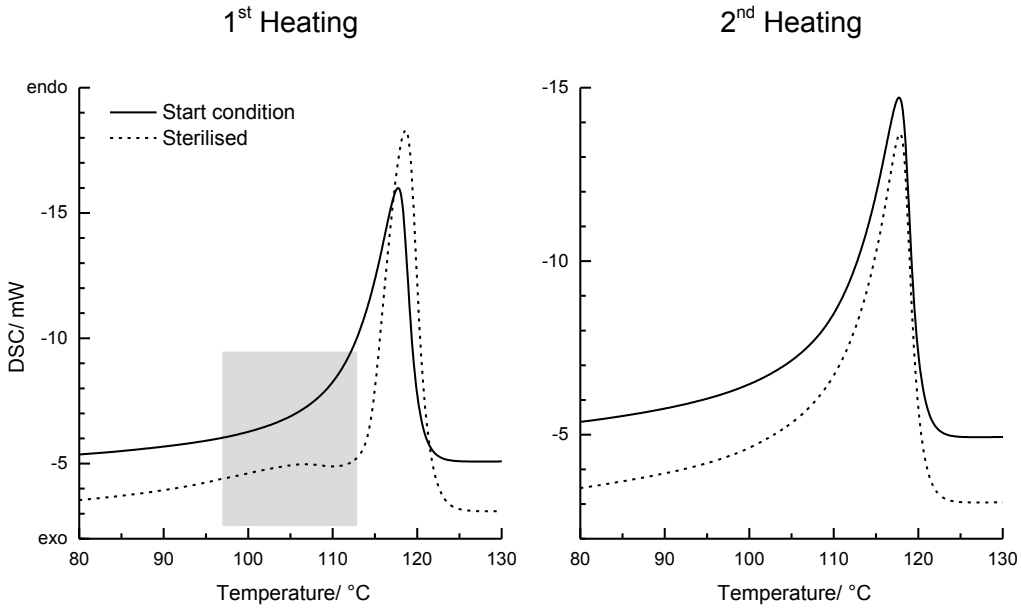

Figure 1: First and second heating of the DSC-measurement of the untreated and the sterilized pre-filled ampoules

This so called “memory effect” of PP melts is discussed in detail in the literature with respect to ethylene content [1] and the influence of ultrasound [2]; however, less attention is given to the effect at temperatures below the melting temperature. This is remarkable since many DSC users know the effects of thermal history during the first heating in DSC experiments.
For the investigations, PP and PE samples of medical products were exposed to steam sterilization or an oven, applying different conditions. Afterwards the samples were measured with DSC. The influences of thermal pretreatment and mechanical stress were analyzed. In addition, various polyolefin reference materials (PE and PP) were investigated to address the influence of composition. In additional, the durability of the signal was examined. Our investigation shows that it is possible to produce a stable memory effect.

[1] S.C. Wang, J. Zhang, S.J. Chen, H. Zhu, Crystal structure and melting behavior of homo-polypropylene and heterophasic ethylene-propylene copolymer after long time heat treatment, Journal of Crystal Growth, 355 (2012) 151-158.
[2] J. Kang, J.Y. Chen, Y. Cao, H.L. Li, Effects of ultrasound on the conformation and crystallization behavior of isotactic polypropylene and beta-isotactic polypropylene, Polymer, 51 (2010) 249-256.