



# Relationship Between Heat and Troughs During a Transport Process of Heating the PET Films

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**Abstract.** Understanding the troughs caused during a heat treatment process is important for ensuring process stability and product quality in roll-to-roll (R2R) productions methodology. The purpose of this study is to confirm the relationship between heat and troughs during a transport process of heating where heat is applied over a wide range of area. The temperature and tension applied to the web during the heated transport process were measured in the experimental analysis. Results showed that the web was stretched in the web transport direction during the heat transfer process. However, troughs did not occur because the experiment was conducted below the glass transition temperature. The comparison between the web temperature obtained in the experimental analysis with the one-dimensional thermal conduction simulation for the temperature distribution of the web are also conducted in this paper. This simulation was performed using a non-Fourier model that can be used on microscales. Simulation results show that when the temperature is gradually raised, the amount of thermal conduction is reduced during transportation of the web. The thermal conduction of ballistic phonon is smaller than that of the diffuse phonon when compared at same distance. Even though there were differences between the experimental values and the simulation results, this is because it ignores the heat transfer and radiant heat transfer.

**Keywords:** Web handling, R2R, PET films, heat transfer, wrinkles

## 1. Introduction

Sheet of flexible material long enough such as paper, plastic film, and metal foils that are familiar to us are called the web and are indispensable to our daily lives. The main products using the web as a substrate are optical films, photovoltaic cells, flexible devices, and so on. Until now, research and development of displays and the like, has progressed, but in the future, mass production of devices with high affinity with humans is expected in the medical field. Figure 1 shows the roll to roll (R2R) processing [1]. Multiple processes in R2R are composed of continuously performed while tensioning, supporting, and transporting the web using many rollers, and winding it into a roll. It can be mass-produced in a shorter time than the conventional continuous flexible medium production process and has the feature of being able to handle various sizes, large and small. However, R2R has many defects, where so far, stable production process has not yet been established. One of the main problems is the troughs that cause wrinkles on the surface of the web due to the stress acting perpendicular to the transport direction of the web. Since the web has elasticity, some wrinkles are restored, but when troughs are concentrated, the elastic modulus of the web is exceeded and wrinkles occur, making it impossible to restore. This will result in the loss of the product value. According to

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