How does rheology control patterns and dissipative mechanisms during tack tests on Pressure Sensitive Adhesives?

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Pressure sensitive adhesives (PSA) are a type of adhesive that can be applied to a surface with minimal pressure and will adhere strongly to that surface. PSAs are widely used in many applications, such as labels, tapes, and medical devices. The adhesion mechanisms of PSAs are complex and not yet fully understood, but several key factors that contribute to the strong adhesion of these materials have been identified [1][2]. Probe tack test is a typical method to characterize a pressure sensitive adhesive (PSA). It consists in measuring the force required to detach a probe from an adhesive surface. The test is typically performed using a probe that is, first, pressed against the adhesive surface, then pulled away at a specific velocity. A probe tack test for a PSA typically involves several stages, including the initial contact, the negative-loading phase, and the detachment phase. In the initial stages of the debonding, cavitation appears under the effect of the strong negative stresses, which corresponds to an increasing force vs displacement. The maximum measured in the displacement/force curve corresponds to the maximum spreading of these cavities. Beyond this stage, the surface of cavities still increases, while the contact lines movement is stopped. Simultaneously, fibrillation phase occurs, in which fibrils are mostly elongated. The final stage of the test is the detachment phase where the adhesive fibrils break within the adhesive, rather than at the adhesive/substrate interface. We report on experiments on PSAs with different rheological parameters. We used an ARES G2 rheometer to perform a tack test between two parallel plates and monitor the associated force and fibril geometries (length and density) using optical methods. The tests results are used to determine the relationship between the different dissipative mechanisms induced in the whole process, by varying temperature, probe velocity and viscosity. Different types of surfaces were also used to initiate different fibrillation patterns.