A new correlation method to obtain the ultimate tensile strength with Small Punch Test and its application to hot-stamping processes

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Abstract. Small Punch Test (SPT) is a miniature mechanical characterization test used as an alternative method to obtain a wide selection of mechanical properties (modulus of elasticity, yield strength, ultimate tensile strength, fracture toughness, etc). The miniature size inherent to SPT shows their application to hot-stamped forming processes in the automotive industry to characterize the alteration of the mechanical properties along different locations. These mechanical properties are obtained in the SPT from correlations with different data obtained in the load-displacement curve of the test (SPT curve). The main limitation of the SPT is the scattering that is observed when a wide selection of materials is included in the correlations. This investigation was focused on the ultimate tensile strength. A finite element analysis (FEM) was performed to understand the SPT behavior, and to analyze the dependency of the data obtained in the SPT curve with this mechanical property. Using these FEM simulations, a new correlation method was proposed using one specific slope of the SPT which shows a lower level of scattering compared with the current methods. Experimental tests on a wide selection of steel alloys, were performed to verify the conclusions obtained with the previous simulations. To show an application of this miniature test in the automotive industry, the ultimate tensile strength of two hardenable boron steels were obtained with the SPT using the new correlation method of this investigation.