1.9 The Bowden and Tabor adhesion model

In 1950 F. P. Bowden and D. Tabor produced a collection of knowledge on friction and lubrication, where it must be noticed that most results given in the book were obtained by themselves. The book "The friction and lubrication of solids" has become the standard work on friction and lubrication for a couple of decades. Based upon their knowledge about friction, Bowden and Tabor presented a simple model for friction on a micrometer scale: The Bowden and Tabor adhesion model or plastic junction model. The model assumes that friction is proportional to both the real area of contact and a mean lateral force per unit area, the so-called shear strength

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$$F_F = \sigma A_R \tag{1.3}$$

where A_R denotes the real area of contact and σ is the shear strength.[d] Since friction is proportional to the real area of contact as is adhesion, the model may be called adhesion model. The energy loss in the friction mechanism is described as plastic deformation of the asperities. Thus, it also may be called plastic junction model. The understanding of friction at the micrometer scale has been reduced to an understanding of two new quantities: shear strength and area of contact.

In the adhesion model all changes of the asperities are assumed to be plastic and therefore the energy loss due to friction is considered as plastic deformation energy of the surfaces in contact.

1.10 The shear strength

The double number of asperities in real contact must produce the double lateral resistance and hence double friction. It is therefore convenient to define the lateral force per unit area, the shear strength σ. It has the dimension of a pressure

$$\sigma = \frac{F_L}{A_R} \tag{1.4}$$

where A_R is the **real** area of contact. The shear strength is a material constant. We will see later, when discussing the real contact area, that experimentally

[d] In the historical context, σ was related to tensile experiments, where plastic deformation in normal direction is observed. Bowden and Tabor assumed that it is identical to the plastic deformation in lateral motion. Later, we will use τ for the shear strength in friction experiments without wear.