DYNAMICS OF WAFER BONDING
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We have developed a model for the propagation of the bonding front as observed for instance in silicon wafer bonding using IR video camera. The velocity of the bonding wave is used in practice to estimate the bonding strength of a bonding assembly with the idea that a faster bonding velocity corresponds to a stronger adhesion energy. Our aim was to make this statement quantitative through a model and compare the predictions of this model to experimental observations.

The basic assumption underlying the model is that the velocity of the bonding is a (dynamical) balance between a driving force and a resistive force.

The driving force is deriving from the binding energy between the two plates. The resistive force is mainly due to the viscous drag of the air flow between the two wafers. We have calculated the air flow between the two binding plates and derived the viscous dissipation resulting from this flow.

We then obtain an expression of the binding front velocity $U$ as a function of the binding energy $2\gamma$ and the plate deformation profile $h(x)$.

$$U = \frac{2\gamma}{\eta} \left( \frac{\Lambda}{\eta^{1/4} (1-\sigma)} \right)^{1/4} \left( \frac{\sqrt{2}}{9\alpha^{1/4}} \right)$$

This equation was checked against experimental data and literature data [1-3]. The effect of gas pressure, viscosity and wafer thickness can be accounted for using this description. The expression also predicts correct values for the bonding front velocity for the different bonding energy achieved using various surface treatments.


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Fig.1: sketch of the deformation with the air flow in between

Next we have made elasticity theory calculations to derive also the wafer deformation as a function of the pressure distribution established during the air flow between the wafers. This calculation predicts a powerlaw profile with exponent 5/3 for the wafer deformation close to the contact line (see Fig.2).