# Tribological Behavior of Rubber on Glass in Prefilled Syringes

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## Abstract

The primary enclosure of an injected formulation is almost exclusively comprised of a glass container (syringe) and an elastomer closure (i.e. plunger). A failed injection is anything that prevents the full dosage of the drug to be administered, whether that is a glass breakage or excessive friction between the rubber plunger and the glass barrel. These failures can both occur due to the tribological properties between glass and rubber. Therefore, understanding friction and wear properties of rubber on glass is particularly important to investigate so as to optimize this system. This excessive friction between the glass and rubber is minimized through the use of siliconizing the glass and the rubber. Figure 1 below shows the subsequent force profile of an ideal syringe during injection.

To examine the friction properties between glass and rubber in a syringe, an axis-symmetric model was developed using the Solid Mechanics interface in the COMSOL Multiphysics® software with a geometry emulating that of the rubber and glass barrel. The model was used to investigate the tribological behavior of silicone rubber against glass, pertaining to the environment of a prefilled syringe. Specifically, the friction, wear and lubrication effects were explored. The surface interaction is accounted for through Hertzian contact mechanics between glass and rubber. Friction phenomena are then explored paying close attention to the time dependent characteristics of friction with rubber. Lubrication is then explored regarding its effect on friction.

## Figures used in the abstract

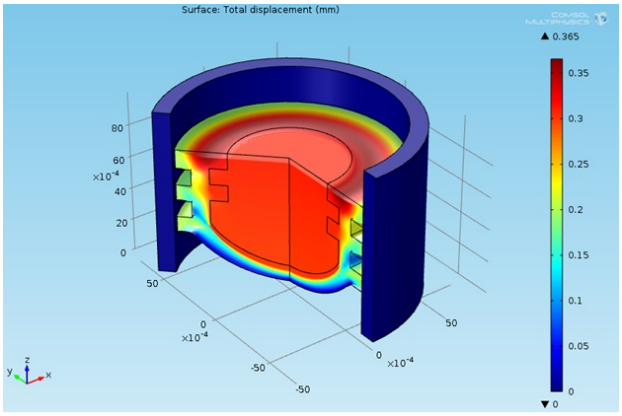


**Figure 1**: Computed displacement of plunger tip in contact with syringe glass barrell