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# Swelling of glucose-responsive gels functionalized with boronic acid

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## Abstract

A model is developed for the elastic response of a glucose-sensitive gel functionalized with boronic acid under swelling in aqueous solutions of glucose with various pH. A gel is treated as a three-phase medium composed of a solid phase (partially ionized polymer network), solvent (water), and solute (mobile glucose molecules and ions). Constitutive equations are derived by means of the free energy imbalance inequality for three-dimensional deformation with finite strains. Numerical analysis demonstrates the ability of the model to describe the effects of pH, molar fraction of glucose, and concentration of functional groups on equilibrium water uptake diagrams under unconstrained and constrained swelling.

**Key-words:** Glucose-responsive gel; Polyelectrolyte; Boronic acid; Swelling

## 1 Introduction

Diabetes mellitus is a metabolic disorder of glucose regulation caused by failure of pancreas to secrete insulin (type-I) or resistance of the body tissue to insulin (type-II). Treatment of type-I and advanced type-II diabetes patients requires continuous glucose monitoring and self-administration of insulin by subcutaneous injections. Development of closed-loop insulin delivery systems mimicking the pancreatic activity has become a focus of attention in the past two decades. Conventional systems involve an external pump for delivery of insulin, a device for continuous sensing of glucose, and a delivery algorithm that

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