



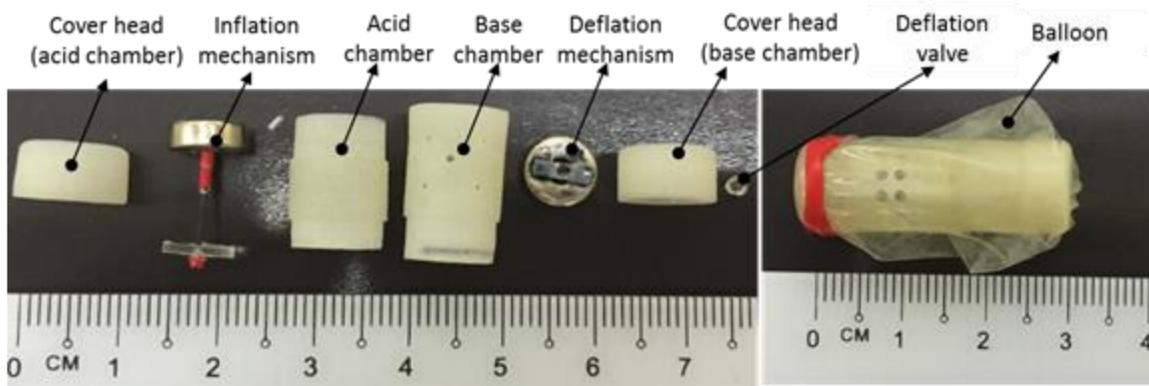
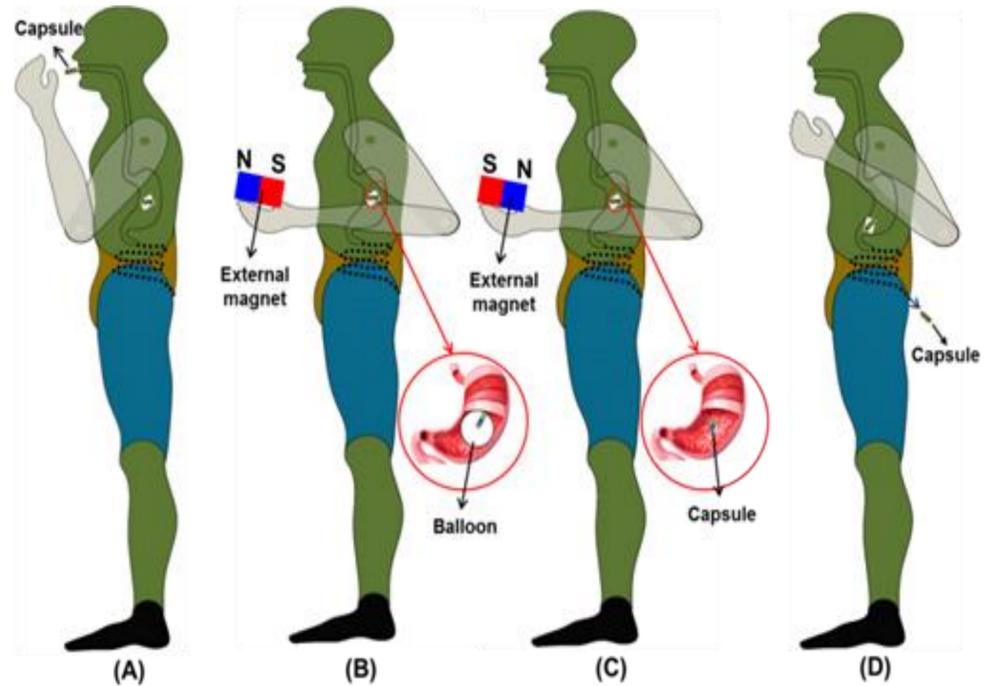
Magnetically Actuated Ingestible Weight Management Capsule

Project Motivation & Objectives

- Intragastric balloons have been developed to induce satiety in patients, leading to weight loss. However, insertion and removal procedures are still relatively complicated, which discourages their use. The balloons must be endoscopically mounted and inflated with a tether.
- Proposed a remotely actuated magnetic capsule that uses an onboard chemical reaction to inflate the balloon. This promises to be a simple and low cost solution. The operating principle is as follows:
 - Capsule swallowed
 - Inflation using South Pole of external magnet
 - Deflation after 3 months using North Pole of magnet
 - Evacuation as part of natural digestive peristalsis

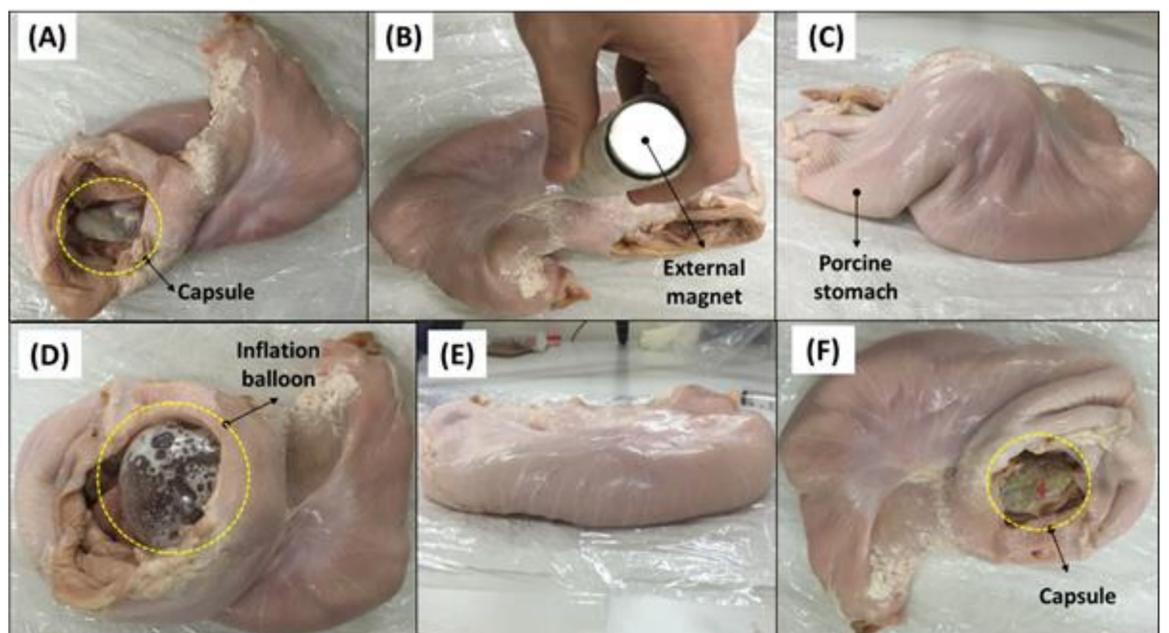
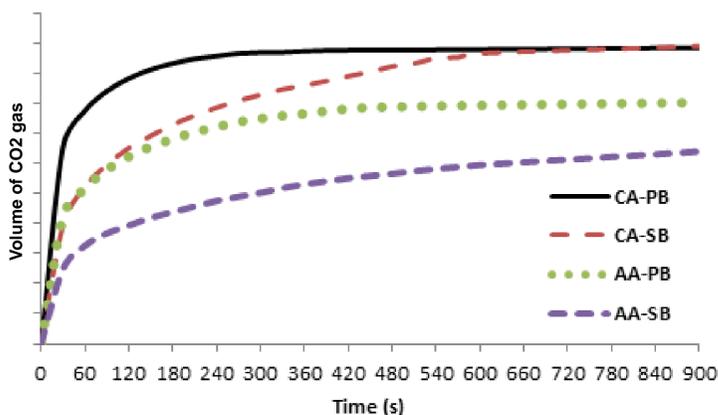
Methodology

- A prototype capsule containing two separate chambers for carrying an acid and a base was created. It measures 33 mm in length and has an outer diameter of 11 mm.
- Shell components were 3D printed using an Objet 350 (Stratasys Ltd.) machine. Neodymium magnets were custom ordered to create the onboard magnetic actuation mechanisms. Two magnets are required, one for inflation and one for deflation. For inflation, the attractive force from the external magnet causes a barrier separating the chemicals to be broken. For deflation, a plug to the environment is dislodged.
- After assembling the components and filling the chemicals, a latex membrane is wrapped over the outside of the capsule to act as a balloon.
- The capsule is tested using a handheld permanent magnet in silicone stomach phantoms and in porcine stomachs. Chemical reaction tests are also performed to determine suitable acid-base combinations.



Results

- The inflation and deflation tests are successful and a 150 ml balloon is produced by a fully loaded capsule.
- Citric acid (CA) and potassium bicarbonate (PB) are selected over acetic acid (AA) and sodium bicarbonate (SB) as the best performing combination of non-toxic chemicals, since they produce more CO₂ gas at a faster rate.



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