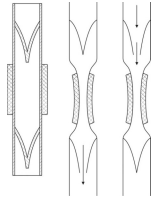


PolyPower based peristaltic pump.

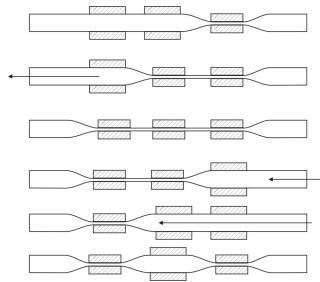
The basic idea is to develop a peristaltic pump based on the Danfoss PolyPower technology (See www.PolyPower.Com).

Basic functionality and data on present material given below. Sizes, length and width not to be considered as constraints.

There are a multitude of design possibilities. For simplicity in explaining the idea, the basic structure could be a short flexible hose, maybe with build in radial springs. Tightly wind sufficient amount of PolyPower film around the hose and place a one way valve at each end of the hose, ensuring a unidirectional flow through the hose when actuated.



A number of these devices may be placed in parallel (a number of actuators may also be placed in series avoiding the use of the check valves).



Actuation could be simultaneously or sequentially or a combination hereof. Keep the energy consumption low by moving the charge from one actuator to another. Place the bundle in a steel pipe with appropriate connections and with a small electronic control on top of it.

Task:

Please consider the problematic and propose a viable and efficient design based on optimal efficiency.

Pump specification:

Volume flow: 2.2 m³/h

Lift: 4 m water column (0.4 bar)

System pressure: 10 bar

Max length of pump: 180 mm

Pipe diameter: 1/2 inch

How efficient a design I achievable? The system may be run at mechanical and electrical resonance.

A number of reasonable models describing the PolyPower actuator as a mass/spring/damper system exist.

BR

Frands Voss

Danfoss Ventures A/S, 2010-08-12

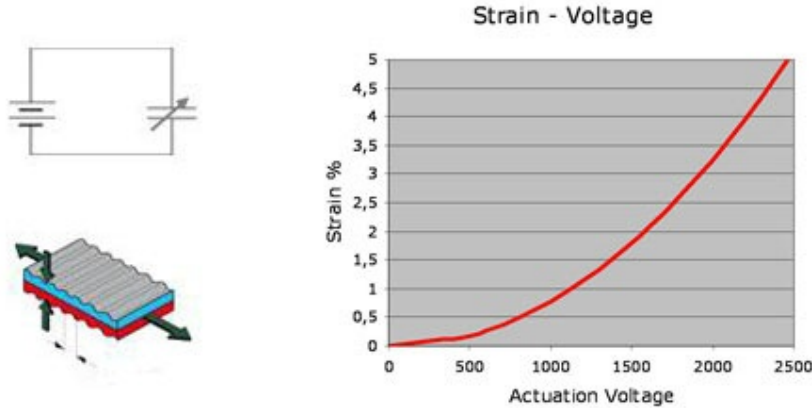
Basic functionality of the PolyPower DEAP smart material

Innovative actuation, sensing and energy harvesting based on the PolyPower technology

Actuation

When applying an electric field across a capacitor, electrostatic forces will try to force the plates of the capacitor towards each other. As the material used in PolyPower film is very soft and cannot be compressed, any compression of the material in one direction will result in an expansion of the material perpendicular to the compression.

This can be utilized to make actuators that directly convert electrical signal into mechanical force or stroke.



PolyPower DEAP material

The PolyPower DEAP (Di-electric Electro Active Polymer) film is based on a thin film of elastomer material. The elastomer material is a silicone of the type PDMS (polydimethylsiloxane) which is a soft material having dielectric withstanding. For more details see table below:

Static Material Properties			
ATTRIBUTE	Unit Of Measure	Demonstrated Current Performance	Expected Performance Medium Term
Dielectric Withstanding	V/ μ m	40	60
Dielectric Constant	Dimensionless	3,1	3,1
Film Thickness	μ m	40	30
Volume Resistance	Ohm cm	$> 10^{14}$	$> 10^{14}$
Density	Kg/m ³	1100	1100

Antisotropic material by design

The PolyPower film has a special micro structured surface pattern on the front surface and a flat back surface. On top of the front surface is deposited a metal electrode, and due to the micro structured surface pattern, the metal electrode is compliant in one direction across the length of the film web and stiff in the perpendicular direction across the film web. The film is manufactured in long length, e.g. 50 m length.

Photo below shows rolls of material:



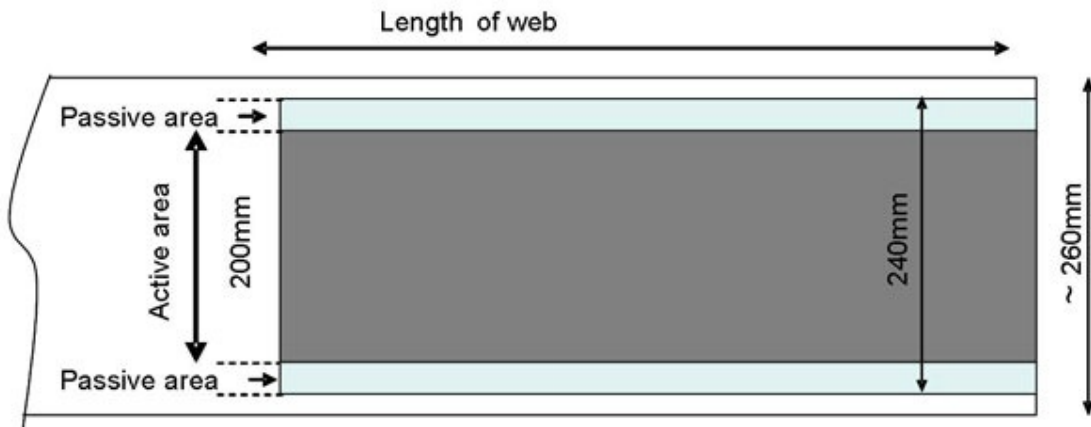
Standard configurations

The film is supplied in a width of 240 mm, and with metal electrodes in one or two tracks.

The single layer PolyPower film can be laminated into various multilayer structures. One standard structure is the back-to-back lamination, where two rolls of single layer film is laminated together, flat back surface of first film against flat back surface of second film.

The area of the laminated film where the elastomer material is between two electrodes is defined as the active area.

To allow good access to contact electrodes outside the active area, the material is shifted during lamination, so first electrode on first film is shifted to one side of laminated film web and electrode on second film is shifted to opposite side of laminated film web, see illustration below.



Standard width of active area is one track of 200 mm or alternatively two track of each 60 mm. The laminated film material can be supplied in various length. The standard length of the film in the evaluation samples is 5m of 240 mm wide (200 mm active area).

In addition, the PolyPower film material is also available as single layer (one side corrugation) and without electrordes. This un-metalized film is intended as a versatile base material for electrical isolation or as elastomeric film for experiments making DEAP film.

Performance

The PolyPower DEAP film is an ideal building block for numerous alternative designs of multilayer structures for actuation and sensing. The actual performance of the material depends on how the actual structure is designed and built.

For estimation of a possible performance range in a certain configuration, the general properties is a good starting point.

Properties for back to back laminated film			
ATTRIBUTE	Unit Of Measure	Demonstrated Current Performance	Expected Performance Medium Term
Elongation	% at 2500V	3%	5%
Load capability (sq area)	N/cm2 at 2500V & 5% elongation	3	5
	N/cm2 at 2500 V & << 0.1% elongation (blocking force)	10	20
Response time	msec	< 10	< 10