УДК 533.52

Muha I., Zui K., Bankovskaya I.

Artificial Muscles

Belarusian National Technical University
Minsk, Belarus

Muscles are organs of the body of humans and animals that consist of elastic muscle tissue capable of contracting under the influence of nerve impulses.

Artificial muscles are devices or materials that mimic natural muscle and can reversibly contract change their stiffness, rotate, or expand with one component by virtue of an external stimulus (such as current, temperature or pressure). The three basic actuation responses: contraction, expansion, and rotation can be combined with a single component to produce other types of motions (e.g. bending). Due to their high versatility, flexibility and power-to-weight ratio, artificial muscles have the potential to be a highly disruptive emerging technology. Being currently in limited use, the technology may have wide future applications in medicine, robotics, industry and many other branches [1].

Comparison with natural muscles: While there is no any general theory that allows for actuators to be compared, there are "power criteria" for artificial muscle technologies that allow for specification of new actuator technologies in comparison with natural muscular properties. In short, the criteria include strain, strain rate, stress, elastic modulus and cycle life. Some authors have considered other criteria such as actuator density and strain resolution. As of 2014, the most powerful artificial muscle fibers in existence can offer a hundredfold increase in power over equivalent lengths of natural muscle fibers.

Researchers measure the power, speed, efficiency and density of artificial muscles; no one type of artificial muscle is the best in all fields. Artificial muscles can be divided into three major groups based on their actuation mechanism:

1) electro-Active Polymers (EAPs) are polymers that can be actuated through the application of electric fields.

2) pneumatic artificial muscles (PAMs) operate by filling a pneumatic bladder with pressurized air.

3) thermal actuation:

a) fishing line - artificial muscles constructed from ordinary fishing line and sewing thread can lift 100 times more weight and generate 100 times more power than a human muscle of the same length and weight.

b) shape-memory alloys - liquid crystalline elastomers, and metallic alloys that can be deformed and then returned to their original shape when exposed to heat, can function as artificial muscles [2].

Artificial muscle technologies have wide potential applications in biomimetic machines, including robots, industrial actuators and powered exoskeletons. EAP-based artificial muscles offer a combination of low power requirements, light weight, agility and resilience for manipulation and locomotion. Future EAP devices will have applications in automotive industry, aerospace, robotics, medicine, entertainment, toys, animation, clothing, transducers, noise control, smart structures and power generators [1].

References:

1. Shape memory alloy [Electronic resource]. – Mode of access: https://instituteofmaking.org.uk/materials-library – Date of access: 28.03.2022.

2. Artificial muscle [Electronic resource]. – Mode of access: https://en.m.wikipedia.org/wiki. – Date of access: 22.03.2022.