

UNIVERSITI TEKNOLOGI MARA

**PARAMETERS STUDY ON THE
FABRICATION OF NICKEL-
TITANIUM SHAPE MEMORY ALLOY
CORE-SHEATH FRICTION YARN
(NiTi-SMA CSFY) via DREF SPINNING
MACHINE**

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Applied Sciences

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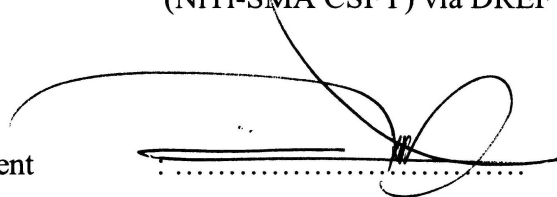
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ABSTRACT

The research focuses on the fabrication, mechanical and actuation performances of Nickel-Titanium Shape Memory Alloy Core-Sheath Friction Yarn (NiTi-SMA CSFY) produced from a DREF 3000 friction spinning machine parameters including spinning drum speed, delivery speed, core-sheath ratio and air-suction pressure. Two types of thin NiTi-SMA wires (SMA MEMRY wire and FLEXINOL Actuator wire) were used as the core of the yarn. Both 100% cotton and polypropylene (PP) fibers were used as the sheath and core fibers respectively. The selected machine parameters were arranged and categorised into several machine parameter plans. The first plan was focused on the determination of the appropriate yarn size to be spun the core-sheath yarn on the DREF 3000 friction spinning machine. The second plan was arranged to investigate the NiTi-SMA CSFY yarn mechanical properties. The third plan was arranged to validate the NiTi-SMA CSFY yarn actuation performance upon the parameters changes, in specific, the spinning drum speed, delivery speed and air-suction pressure. The appropriate Tex value was found to be 320 Tex as it was successfully spun the NiTi-SMA CSFY yarn without caused of machine stoppages. The results showed that the strength of both NiTi-SMA CSFY yarns (from SMA MEMRY wire and FLEXINOL Actuator wire) declined as the core-sheath ratio and delivery speed increased from 40 to 60% and 100 to 160m/min respectively. The strip resistance of the NiTi-SMA CSFY yarn (SMA MEMRY wire) increased with the increase in the spinning drum speed, delivery speed and core-sheath ratio. Under the thermal heating test, the actuation time of the NiTi-SMA CSFY (SMA MEMRY wire) yarn reduced approximately 5 to 93%, 39 to 91% and 15 to 87% as the spinning drum speed increased from 3000 to 4400rpm and core-sheath ratio from 40 to 60%, respectively. The NiTi-SMA CSFY yarn (FLEXINOL Actuator wire) showed faster shape recovery at approximately 0.01s in comparison with the NiTi-SMA CSFY yarn (SMA MEMRY wire) when it was heated through the resistive heating test. The pre-set shape of the SMA MEMRY wire (spiral annealed) and FLEXINOL Actuator wire (straight annealed) gave different NiTi-SMA CSFY yarn physical appearances, mechanical properties, actuation performance and affected the SMA wire actuation performances in both the woven and knitted fabric structures.

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