SMART MATERIALS FABRICATED BY POWDER METALLURGY: A REVIEW

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

SMART MATERIALS FABRICATED BY POWDER METALLURGY: A REVIEW

Smart Materials (SM) are innovative materials with several applications, including the aerospace sector, biomedicine, and others. Shape memory alloys (SMA), piezoelectric materials, magnetostrictive materials, and electrostrictive materials are some of the categories. Powder metallurgy (PM) is the study of metal powder processing, which involves the synthesis, characterization, and conversion of metal powder into usable engineering components. The benefits of the PM technique include the ability to create unique designs that are difficult to construct using standard techniques, as well as the economic and distinctive characteristics of PM to generate multipart products, which make SM fabricated by PM increasingly appealing for substituting wrought materials. Several studies on SM and PM have been conducted; nevertheless, there are far too many powder metallurgical approaches for producing SM. As a result, researchers are unable to determine which strategy is optimal for increasing the characteristics of SM using PM, hence development is slow. The purpose of this study is to examine the evidence for a relationship between SM and PM. Based on the results, shape memory polymers (SMPs) are the best form of SMAs since they have great strain recovery, low density, cheap cost, simple manufacture, biocompatibility, biodegradability, mouldability, and lightweight. Furthermore, due to its lead-free perovskite, high dielectric permittivity, and good piezoelectric coefficient, $BaTiO_3$ is regarded as the best piezoelectric material. Direct Ink Writing and Spark Plasma Sintering are the ideal production technologies for SMPs and $BaTiO_3$, respectively. This research will be valuable to academics seeking the best PM techniques for SMPs and $BaTiO_3$. The present trends in SMP and $BaTiO_3$ production were the primary focus of this review. In the future, this study should provide more detailed information on advanced PM approaches, notably DIW and SPS.

ABSTRAK

FABRIKASI BAHAN PINTAR OLEH METALURGI SERBUK: SEBUAH ULASAN

Bahan Pintar (SM) adalah bahan inovatif dengan beberapa aplikasi, termasuk sektor aeroangkasa, bioperubatan, dan lain-lain. Aloi ingatan bentuk (SMA), bahan piezoelektrik, bahan magnetostriktif, dan bahan elektrostriktif adalah antara kategori SM. Metalurgi serbuk (PM) adalah kajian pemprosesan serbuk logam, yang melibatkan sintesis, pencirian, dan penukaran serbuk logam menjadi komponen kejuruteraan yang boleh digunakan. Kelebihan teknik PM merangkumi kemampuan membuat reka bentuk unik yang sukar dibina menggunakan teknik piawai, serta ekonomi dan ciri khas PM untuk menghasilkan produk pelbagai bahagian, yang menjadikan SM dihasilkan oleh PM semakin menarik untuk menggantikan bahan tempa.Beberapa kajian mengenai SM dan PM telah dijalankan; namun begitu, terdapat terlalu banyak kaedah PM untuk menghasilkan SM. Akibatnya, penyelidik tidak dapat menentukan strategi yang optimum untuk meningkatkan ciri-ciri SM menggunakan PM, justeru perkembangan kajian ini adalah perlahan. Tujuan kajian ini adalah untuk mengkaji bukti hubungan antara SM dan PM. Berdasarkan hasil kajian ini, polimer ingatan bentuk (SMP) adalah jenis SMA terbaik kerana ia mempunyai pemulihan regangan yang hebat, kepadatan rendah, kos murah, proses pembuatan yang mudah, biokompatibiliti, biodegradasi, kebolehkemasan, dan ringan. Selanjutnya, kerana perovskite bebas plumbum, permitiviti dielektrik yang tinggi, dan pekali piezoelektrik yang baik, $BaTiO_3$ dianggap sebagai bahan piezoelektrik terbaik. *Direct ink writing* (DIW) dan *spark plasma sintering* (SPS) adalah teknologi pemprosesan yang ideal untuk SMP dan $BaTiO_3$. Penyelidikan ini akan berguna kepada ahli akademik yang mencari teknik PM terbaik untuk SMP dan $BaTiO_3$. Trend semasa dalam penghasilan SMP dan $BaTiO_3$ adalah fokus utama dalam ulasan ini. Pada masa hadapan, kajian ini harus diperbaiki dengan memberikan maklumat yang lebih terperinci mengenai pendekatan PM lanjutan, terutamanya DIW dan SPS.

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