OPTIMISATION OF ELECTRICAL DISCHARGE MACHINING FOR OXIDATION-FREE METALLIC NANOPARTICLE SYNTHESIS OF TITANIUM ALLOY

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We hereby declare that We have checked this thesis, and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the Doctor of Philosophy.

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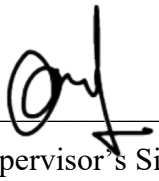

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Pelbagai bahan dan teknik sintesis kimia telah disiasat untuk membangunkan nanozarah yang lebih berkualiti dengan bentuk, saiz, dimensi dan sifat dinamik yang seragam. Pembangunan zarah nano yang ditakrifkan (NP) dengan sifat khusus masih dalam pencarian; Oleh itu, dalam kerja ini, pendekatan menggunakan pemesinan nyahcas elektrik (EDM) untuk menjana zarah nano disiasat. Proses EDM yang telah ditetapkan telah digunakan untuk menghasilkan nanozarah seragam dengan sifat berkaitan permukaan yang cekap. Pemesinan nyahcas elektrik ialah proses pembuatan yang digunakan secara meluas untuk menghasilkan bahagian yang tepat dan terperinci, terutamanya acuan, acuan dan bentuk kompleks lain. Proses ini melibatkan penggunaan elektrod untuk menghasilkan nyahcas elektrik melalui bahan kerja, mencairkan dan mengewap bahan untuk mencapai bentuk yang diingini. Dalam tahun-tahun kebelakangan ini, kawasan ini telah melihat kemajuan yang ketara dalam kemasan permukaan yang lebih baik, fleksibiliti yang lebih besar dan Peningkatan ketepatan dan ketepatan. Kemajuan ini telah menjadikan EDM sebagai alat yang lebih berharga untuk pelbagai industri dan membolehkan pengeluaran alat ganti berkualiti tinggi dengan kecekapan dan ketepatan yang lebih tinggi. Hasil daripada kemajuan baru, mesin ini boleh mensintesis nanopartikel dalam bentuk derbi sisa. Dalam beberapa tahun kebelakangan ini, ini telah muncul sebagai fenomena yang menarik minat luar biasa untuk sintesis zarah nano oleh EDM. Secara amnya dipersetujui bahawa EDM boleh mensintesis zarah nano. Walau bagaimanapun, ini adalah soal perbincangan berterusan dan pengoptimuman dan kemas kini selanjutnya. Beberapa penyelidik telah cuba menyelesaikan masalah ini, yang masih dalam siasatan. Kerja ini mencadangkan cara mudah untuk menangani isu ini menggunakan proses pengoptimuman dan menambah asid oleik sebagai agen penutup dengan dielektrik dan sintesis nanozarah titanium dan kuprum. Keputusan ini diukur menggunakan pendekatan SEM, TEM, XRD, TGA/DTA dan FT-IR. Kaedah ini telah menunjukkan peningkatan yang ketara dalam kualiti sintesis bahan dan menghasilkan nanozarah bebas pengoksidaan. Dalam mensintesis aloi Ti dan kuprum melalui pemesinan nyahcas elektrik, parameter utama yang mempengaruhi sintesis ialah jurang semasa, tepat masa, masa luar dan alatan. Kajian ini dijalankan menggunakan reka bentuk eksperimen RSM untuk membangunkan NP. Penemuan eksperimen dan keputusan pengoptimuman, arus 6A, masa nadi hidup 60 ns, masa mati nadi 40 ns, dan minyak tanah sebagai dielektrik, membolehkan fabrikasi 10 mm hingga 20 μm nanopartikel sfera aloi titanium dan tembaga. Voltan tinggi digunakan untuk menghasilkan zarah bersaiz 100 hingga 200 μm. Asid oleik digunakan pada permukaan sebagai agen penutup untuk cecair dielektrik untuk mendapatkan zarah bebas pengoksidaan. Hasil paparan SEM bagi saiz zarah sfera 20 μm purata dan EDX tidak menunjukkan unsur lain yang berkaitan. Graf FT-IR mewakili kumpulan berfungsi asid oleik sebagai agen penutup yang menghalang zarah daripada pengoksidaan. XRD mencirikan sifat struktur zarah tersintesis untuk kekal sama seperti sebelumnya. Tiada perubahan struktur kristal atau perubahan fasa dikesan dalam sifat bahan.

ABSTRACT

Various materials and chemical synthesis techniques have been investigated to develop better-quality nanoparticles with uniform shapes, sizes, dimensions, and dynamic properties. The development of defined nanoparticles (NP) with specific properties is still in search; therefore, in the present work, an approach using electrical discharge machining (EDM) to generate nanoparticles is investigated. The established EDM process has been used to generate uniform nanoparticles with efficient surface-related properties. Electrical discharge machining is a widely used manufacturing process for producing precise and detailed parts, particularly dies, moulds, and other complex shapes. This process involves using an electrode to generate electrical discharges through a workpiece, melting and vaporising the material to achieve the desired shape. In recent years, this area has seen significant advances in improved surface finishing, greater flexibility and Increased accuracy and precision. These advancements have made EDM an even more valuable tool for a wide range of industries and enabled the production of high-quality parts with greater efficiency and precision. As a result of new advancements, this machine can synthesise nanoparticles in the form of waste derbies. In just the past few years, this has emerged as a phenomenon of exceptional interest for nanoparticle synthesis by EDM. It is generally agreed that EDM can synthesise nanoparticles. However, this is a matter of ongoing discussion and further optimisation and update. Some researchers have attempted to solve these problems, which are still under investigation. The present work proposes a simple way to address this issue using an optimisation process and to add oleic acid as a capping agent with dielectric and synthesis nanoparticles of titanium and copper. These results were measured using SEM, TEM, XRD, TGA/DTA and FT-IR approaches. These methods have demonstrated a marked improvement in the quality of material synthesis and produced oxidation-free nanoparticles. In synthesising Ti alloys and copper by electrical discharge machining, the main parameters affecting the synthesis were current, on-time, off-time, and tool gap. The present study was conducted using the RSM experimental design to develop NPs. The experimental findings and optimisation results, a current of 6A, a pulse-on time of 60 ns, a pulse-off time of 40 ns, and kerosene as the dielectric, enabled the fabrication of 10 mm to 20 μm spherical nanoparticles of titanium alloy and copper. High voltage was used to produce 100 to 200 μm sized particles. Oleic acid was used on the surface as a covering agent for the dielectric fluid to obtain oxidation-free particles. SEM Exhibit result of average 20 μm spherical size of particles and EDX revealed no other elements associated. FT-IR graph represents a functional group of oleic acid as a capping agent that prevents the particle from oxidation. XRD characterised the structural properties of synthesised particles to remain the same as before. No crystalline structure changes or phase changes are detected in the material property.

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