Desain Metode Pemilihan Material Paduan Alumunium Berbasis Deep Learning = Aluminum Alloy Material Selection Method Based on Deep Learning

Raihan Kenji Rizqillah, author

Abstrak

Fatik menjadi salah satu indikator utama yang menjadi perhatian pada penggunaan paduan alumunium sebagai aplikasi struktural pesawat terbang, dimana sebanyak lebih dari 50% kecelakaan dirgantara disebabkan oleh kegagalan fatik material. Metode eksperimental trial and error untuk mendesain material memerlukan waktu panjang, biaya tinggi, serta efisiensi penelitian yang dipengaruhi oleh intuisi dan keberuntungan dari peneliti menimbulkan urgensi pendekatan lain dalam penelitian mekanika material. Penelitian mekanika material berbasis Pembelajaran Mesin (PM) dapat memanfaatkan data-data eksperimen dan penelitian terdahulu, sehingga dapat memangkas biaya dan waktu penelitian. Pada penelitian ini telah berhasil dikembangkan dua model deep learning yang mampu memetakan dengan baik hubungan antara data paduan alumunium dengan sifat fatik yang dihasilkan. Model dibuat dengan arsitektur Deep Neural Network menggunakan TensorFlow. Model S2P (Structure to Performance) dapat memprediksi performa fatik suatu paduan alumunium dari data komposisi, perlakuan panas, sifat mekanis, dan pembebanan fatik yang diterima. Model P2S (Performance to Structure) dapat memprediksi komposisi paduan alumunium yang dapat memenuhi performa fatik yang diharapkan. Kedua model menghasilkan performa baik berdasarkan pada metrik penilaian R2, yaitu senilai 0,92 untuk model S2P dan 0,96 untuk model P2S. Formula matematika sifat mekanis dan sifat fatik paduan alumunium dibuat sebagai fungsi dari variabel unsur paduan dan perlakuan panas. Pengembangan model deep learning prediksi sifat paduan alumunium berbasis fitur atomik menunjukkan bahwa total elektronegatifitas berpengaruh besar terhadap sifat mekanis dan sifat fatik.

..... Fatigue is one of the main concern of the utilization of aluminum alloys as aircraft structural applications, since more than 50% of aerospace accidents are caused by material fatigue failure. The experimental trial and error method for designing materials requires long time and high costs. Research efficiency is also influenced by intuition and luck of the researcher. These condition raises the urgency of other approaches in material mechanics research. Machine Learning (ML) based material mechanics research can take advantage of experimental data and previous research, which ables reduce research costs and time. In this research, two deep learning models have been successfully developed. The models are able to map the relationship between aluminum alloy data and the resulting fatigue properties. The model is built on a fully connected Deep Neural Network architecture using TensorFlow. The S2P (Structure to Performance) model can predict the fatigue performance of an aluminum alloy from the data of composition, heat treatment, mechanical properties, and fatigue loading condition. The P2S (Performance to Structure) model can predict the composition of aluminum alloys that can meet the expected fatigue performance. Both models produce good performance based on the R2 scoring metric, which is 0.92 for the S2P model and 0.96 for the P2S model. Mathematical formulas for mechanical properties and fatigue properties of alloys are made as a function of alloying and heat treatment variables. The development of atomic feature based deep learning model shows that the total electronegativity has a large impact on the

mechanical properties and fatigue properties.