中国有色金属学报
中国有色金属学报(英文版)
中国科学技术协会 主管
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论文摘要

中国有色金属学报
ZHONGGUO YOUSEJINSHUXUEBAO XUEBAO
第17卷 第12期 (总第105期) 2007年12月

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文章编号：1004-0609(2007)12-1948-07

PLS-BPN法用于7005铝合金力学性能与工艺参数的定量研究

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摘 要：用偏最小二乘法(PLS)结合反向传播人工神经网络(BPN)方法对7005铝合金力学性能与工艺参数之间的关系进行定性分析和计算。结果表明：用PLS法对实验数据作模式识别优化处理的结果与实验很吻合，能够指明该合金工艺参数优化的方向；用BPN定量计算的结果与实验测定值符合也较好；将PLS与BPN法有机地联系起来，有利于克服过拟合，提高BPN预报的准确性。用留一(LOO)交叉验证法分别对3种模型PLS、BPN和PLS-BPN的合金性能预报结果进行验证，其中PLS-BPN模型预测的均方根误差(RMSE)和平均相对误差(MRE)均最低，更适合于7005铝合金性能预报。

关键字： 7005铝合金；偏最小二乘法(PLS)；神经网络(BPN)；PLS-BPN；留一(LOO)交叉

Quantitative study between mechanical properties and processing parameters for 7005Al alloys predicted using PLS-BPN method

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Abstract: The mechanical properties of 7005 Al alloys were qualitatively analyzed by partial least squares(PLS) method and quantitatively calculated by using back propagation artificial neural network(BPN) with the same processing parameters as features. The calculated results are in agreement with experimental ones basically. In order to solve the overfitting problem, a novel method hybridizing PLS and BPN to forecast the mechanical properties of the alloys was proposed and tested. PLS method can compute the scores for the principal components according to the sorts of components and thus compress the input data for BPN with linear arithmetic. The forecasting performances were compared with each other by using leave-one-cross-validation(LOOCV) among three models, i.e. the hybrid model(PLS-BPN), BPN model and PLS model. The root mean squared error (RMSE) and the mean absolute relative error (MRE) of PLS-BPN are the lowest. Consequently, the hybrid model is more suitable to forecast the mechanical properties of the alloys.

Key words: 7005Al alloys; partial least squares(PLS); back propagation network(BPN); PLS-BPN; leave-one-cross (LOOC)

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