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高温稀土永磁合金$Sm_2(Co,Cu,Fe,Zr)_{17}$

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摘 要：利用粉末冶金的方法研制了3种成分为$Sm(Co_{bal}Fe_{0.24}Cu_{0.08}Zr_{0.027})_{7.0}$，$Sm(Co_{bal}Fe_{0.27}Cu_{0.05}Zr_{0.027})_{7.0}$，$Sm(Co_{bal}Fe_{0.26}Cu_{0.05}Zr_{0.026})_{7.0}$的高温永磁合金，并对其磁性能、温度稳定性和显微结构进行了分析.研究结果表明：常温时，3种永磁合金都具有较高的磁性能，其中，合金样品$Sm(Co_{bal}Fe_{0.27}Cu_{0.05}Zr_{0.027})_{7.0}$的内禀矫顽力(2 165.6kA·$m^{-1}$)和磁能积(212.0 kA·$m^{-3}$)最大；200℃时，3种合金的磁性能降低，但仍具有较大值；增加Co和Fe的含量，可提高材料的剩磁，当Zr的含量较大时，合金的矫顽力较高；3种磁体的温度系数都较低，最高使用温度均在400℃以上，大大高于一般商用磁体的使用温度；增加Sm，Co，Cu的含量和减少Fe的含量可以提高材料的温度稳定性；合金中含有$Sm_2(Co,Fe)_{17}$主相、$Sm(Co,Cu)_5$相、Zr的化合物等；$Sm(Co,Cu)_5$相、单质Zr、晶粒边界等钉扎畴壁，使合金具有较高的矫顽力.

关键字：高温永磁；磁性能；温度系数；冶金

High temperature $Sm_2(Co,Cu,Fe,Zr)_{17}$ permanent magnets

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Abstract: Three high temperature magnets, including $Sm(Co_{bal}Fe_{0.24}Cu_{0.08}Zr_{0.027})_{7.0}$, $Sm(Co_{bal}Fe_{0.27}Cu_{0.05}Zr_{0.027})_{7.0}$, and $Sm(Co_{bal}Fe_{0.26}Cu_{0.05}Zr_{0.026})_{7.0}$, are produced by powder metallurgy techniques . The magnetic properties, temperature stability and microstructure are analyzed in this article. The results show that $Sm(Co_{bal}Fe_{0.27}Cu_{0.05}Zr_{0.027})_{7.0}$ has a highest intrinsic coercive force of 2 165.6 kA·m^{-1}, and a maximum energy product of 212.0 kA·m^{-3}. The three alloys have low temperature coefficients of coercivity, and the maximum operating temperatures of the three magnets all exceed 400℃, which are greatly higher than those of the commercial Sm_2Co_{17} alloys. Thermal stability can be improved by applying higher content of Sm, Co, Cu and lower content of Fe. Through the analysis of microstructure, we found that $Sm_2(Co,Fe)_{17}$main phase, $Sm(Co,Cu)_5$ phase, Zr-rich compound and Zr in the alloys. $Sm(Co,Cu)_5$, Zr and cell boundary may pin the domain wall, so as to improve the coercivity.

Key words:high temperature permanent magnets; magnetic properties; temperature coefficient; alloys

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