Proceedings of the Korean Superconductivity Society Meeting 1999
(KSS 99), YongPyung, Kangwondo, Korea, Aug. 18-20, 1999

Effect of Pd impurity on the Cube-texture in Cold Rolled and Recrystallized PtPd alloy for the Application to RABiTS

초전도 테이프 기판을 위한 PtPd 합금의 압연 및 재결정 정렬에 대한 Pd 첨가물의 영향

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We investigated the effects of Pd impurities on cube-textures in cold rolled and recrystallized PtPd tapes The sample were made from $Pt_{1-x}Pd_x$ alloys (x from 0 to 0.34) by rolling at low temperature. The thickness of the tapes were about 100㎛. The PtPd[111] pole figures of X-ray Diffraction for all the samples indicated similar deformed textures. But the recrystallized textures after annealing showed that a better cube texture was formed in the sample of larger x. The final textures were sensitive to annealing time and temperature when x was increased.

1. Introduction

RABiTS (Rolling Assisted Bi-Axially Textured Substrate) is a very useful technique for fabrication of coated conductors. Goyal *et al* [1-2] succeed in the fabrication of $YBa_2Cu_3O_{7-\delta}$ coated conductors with $j_c > 10^5$ A/㎠ using Ni tape substrate made by RABiTS. There are many applications of very long super-conducting tapes, for example, a high field magnet, a magnetic shield, etc.

But Ni is a ferromagnetic metal, which has been thought to be a disadvantage for such applications. Hence we tried to find out nonmagnetic substrate, for instance, Ag, Cu, Pt, etc. Most f.c.c. metals may be candidates for RABiTS. However, the reactivity with oxygen restricts the use of the substrate for the coated conductors.

We think that Pt can be a possible material to solve such problems, spacially for small scale application[3]. In addition, Pt tapes have an advantage which is no crack in buffered CeO_2 film, unlikely those on Ni[4].

In general, a commercially available Pt has much Pd impurities. So we investigate the effects of Pd on the cube texture of Pt. The recrystallized PtPd alloys are stiffer than pure recrystallized Pt, or Ni. This stiffness of PtPd alloys is another advantage to fabricate coated conductor on it.

2. Experimentals

$Pt_{1-x}Pd_x$ (x=0.2, 0.14, 0.34) alloys were prepared by arc melting. Pt, Pd atomic ratio was analysed by EDS (Energy Dispersive Spectroscopy). We made 5㎜×5㎜(thickness)×10 ㎜ rods from these alloys.

$Pt_{1-x}Pd_x$ (x=0.2, 0.14, 0.34) rods were rolled into 100-110㎛ in two different processes. One was ordinary room temperature rolling, the other was liquid nitrogen - cooled rolling (low temper- ature), that was, one minute dipping in liquid nitrogen after each rolling step. We observed deformed textures by X-Ray Diffraction pole figure, and ODF (Orient Distribution Function) using <111>, <200>, <220> pole figures.

We varied the annealing temperature from 1000℃ to 1600℃ using a tungsten heater and also varied the time needed for the temperature was changed from the room temperature to the annealing temperature. The annealing chamber's base pressure was 10^{-5} Torr. We also measured the recrystallization textures by X-Ray Diffraction pole figures.

We deposit $YBa_2Cu_3O_{7-\delta}/CeO_2/YSZ/CeO_2$ on the well cube-textured PtPd tape. The detailed descriptions on the experimental conditions of the film deposition are given ref 3. A $YBa_2Cu_3O_{7-\delta}$ film and buffer layers also grow biaxially textured. the zero-resistance Transition temperature was 87K.

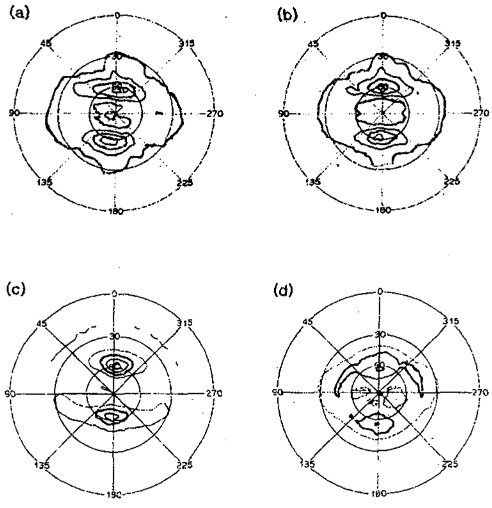

Fig3.1 XRD $Pt_{1-x}Pd_x$ <111> pole figures for the deformation textures of the samples rolled at (a), (b), (c) low temperature and (d) room temperature rolling condition. x=(a)≤0.2 (b)0.14, (c) and (d)0.34

3. Results

3-1. Deformation Texture

Figure 3.1 show the deformation texture of $Pt_{1-x}Pd_x$ (x=0.2, 0.14, 0.34) alloys by room tem- perature rolling, and low temperature rolling, which are very similar but we observe differ- ences by ODF analysis.

3-2. Recrystallization Texture

Almost pure Pt(L) ($Pt_{1-x}Pd_x$: x≤0.2), rolled in the liquid nitrogen, shows a 45° rotated cube texture (Figure 3.2(a)). In other word, it is also biaxially textured where the <002> axis is aligned normal to the surface, and the <110> axis is aligned along the rolling direction. It is concerned that there is no other component in

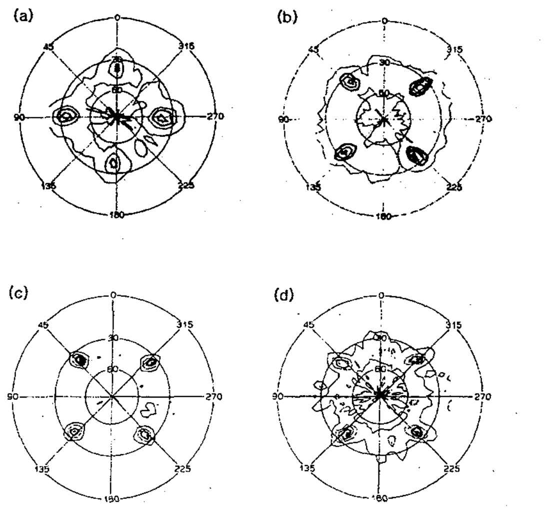

Fig3.2 Recrystallization textures observed by XRD $Pt_{1-x}Pd_x$ <111> pole figures corresponding to Figure 3.1 (a) (b) (c) (d) after annealing at 1400℃ for 2 hours.

the pole figures of this sample, <220> or <311>. This is a very different result compared with the ordinary RABiTS Ni, or the other f.c.c. metals, whose <100> axes are aligned along rolling direction. when this sample Pt (R) is rolled at the room temperature, it has a slightly mixed texture of a cube and a 45° rotated cube textures.

Recrystallization of $Pt_{0.86}Pd_{0.14}$(L) tape rolled at low temperature appears almost cube textured (Figure 3.2(b)), but the <220> pole figure show a weak Goss component {110}<100> (Figure 3.3(a)). When the final annealing temperature is 1200℃, that is, lower by 200℃, or the temperature- increasing rate was more faster, the Goss component became stronger as shown in Figure 3.3(b).

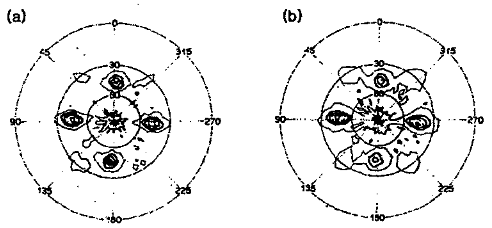

Fig3.3 Recrystallization textures observed by X-ray Diffraction $Pt_{0.86}Pd_{0.14}$ <220> pole figures corresponding to Figure 3.2 (b) sample.

The recrystallization of $Pt_{0.86}Pd_{0.14}$(R) tape rolled at room temperature appeared uni-axially textured. The <002> axes were aligned normal to the surface.

$Pt_{0.66}Pd_{0.34}$(L) tape rolled at low temperature appear well cube - textured, typical RABiTS while the recrystallized as observed is $Pt_{0.66}Pd_{0.34}$(R) tape, rolled at room temperature, showed poor cube texture. The out-of-plane alignment was within 10° according to FWHM (Full Width and Half Maximum) of rocking curve $Pt_{0.66}Pd_{0.34}$(L), and in-plane alignment was within 8°, according to FWHM of $Pt_{0.66}Pd_{0.34}$(L) <111> φ-scan.

We have obtained very interesting results. To be short, first, PtPd deformed by liquid nitrogen cooled rolling process is recrystallized into bi-axially texture, and second, the better cube texture forms, the larger x in $Pt_{1-x}Pd_x$. It is known that the temperature, beyond which a mechanical twining is impossible, drops rapidly as the stacking fault energy (SFE) rises [5]. In our experiment, Pd impurity and lowering deformation temperature have same effect on the deformation texture, that is, increasing twining by decreasing SFE. We don't know yet why increasing twining drives into cube texture in annealing process. In Makoto Koizumi *et al'* paper[6], the texture in the annealed Al -Mg a cube texture was developed as increased Mg content. They explain this results by solute drag effect - impurity suppressed grain growth rate. Pd in Pt is also thought to play the same role, which cannot explain the relation between deformation and the recrystallization.

3.3 $YBa_2Cu_3O_{7-\delta}$ film characteristics

We obtain cube textured RABiTS only by decreasing rolling temperature and subsequent annealing at 1400 - 1500℃ with only $Pt_{0.66}Pd_{0.34}$ alloy. We deposite $YBa_2Cu_3O_{7-\delta}/CeO_2/YSZ/CeO_2$ on this tape of which XRD 2θ-scan is shown in Figure 3.4(a). All layers grow [002] axis with a nomal.. Fig 3.4(b) show that $YBa_2Cu_3O_{7-\delta}$ has also in-plane texture. The transition temperature was 87K.

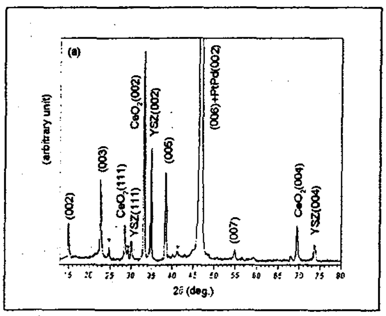

Fig3.4(a) XRD 2θ-scan of $YBa_2Cu_3O_{7-\delta}/CeO_2/YSZ/CeO_2/Pt_{0.66}Pd_{0.34}$

So we think that $Pt_{0.66}Pd_{0.34}$ can be good candidate for superconductor coated conductors. A further study on magnetic and mechanical properties etc. are planned comparatively with Ni as their substrates.

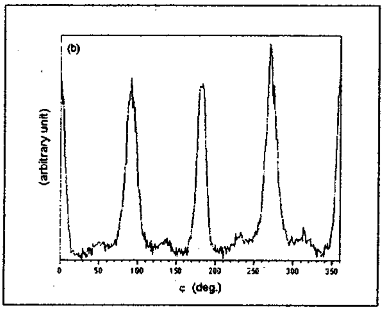

Fig3.4(b) XRD [103] φ-scan of $YBa_2Cu_3O_{7-\delta}$

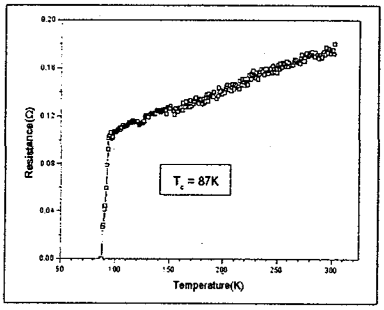

Fig.3.5 Resistance vs temperature curve of $YBa_2Cu_3O_{7-\delta}$

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