Innovative Superconducting DC Cable Using the Longitudinal Magnetic Field Effect

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The merits of superconducting DC cable are no AC loss and a simple cable structure in comparison with AC cables. In addition, the longitudinal magnetic field effect that can enhance the current-carrying capacity can be used. Main points of the innovative superconducting DC cable with this effect are to use the current flowing back through the outside shield conductor to apply a parallel magnetic field to the inner conductor and to realize the force-free structure in the inner conductor under this parallel magnetic field[1)]. Since the critical current density in present commercial REBCO coated conductors does not increase sufficiently in a parallel magnetic field, a modification is necessary for the structure of the inner conductor. Then, the optimum design was investigated for the structure of the inner conductor based on the observed critical current density of these coated conductors[2)]. A simple calculation showed that the current-carrying capacity could be significantly enhanced from those of the conventional cables, although the capacity was lower than that of the force-free cable. It was emphasized that this structure is also applicable to Bi-2223-tapes. Then, a preliminary experimental investigation was carried out for a single layer conductor made with Bi-2223-tapes in applied longitudinal magnetic field. It could be shown that the critical current of the conductor took a peak value under the condition where the total magnetic field was parallel to the winding direction of the tapes. Based on this result we theoretically estimated the current-carrying capacity of the innovative three-layer cable made with Bi-2223 tapes. It was found that the current-carrying capacity can be enhanced by 13 % in comparison with the cable of conventional type.