⑬ Nitride-Based Heterojunction Bipolar Transistors (HBTs)

Motivation

Group-III nitrides are expected to be applied to high power and high temperature operation electron devices due to their wide bandgap. However, predicted superior characteristics have never been achieved for nitride-based HBTs due to the low crystal quality or immature fabrication process. The purpose of this work is to investigate the excellent properties of group-III nitride semiconductors after solving these problems.

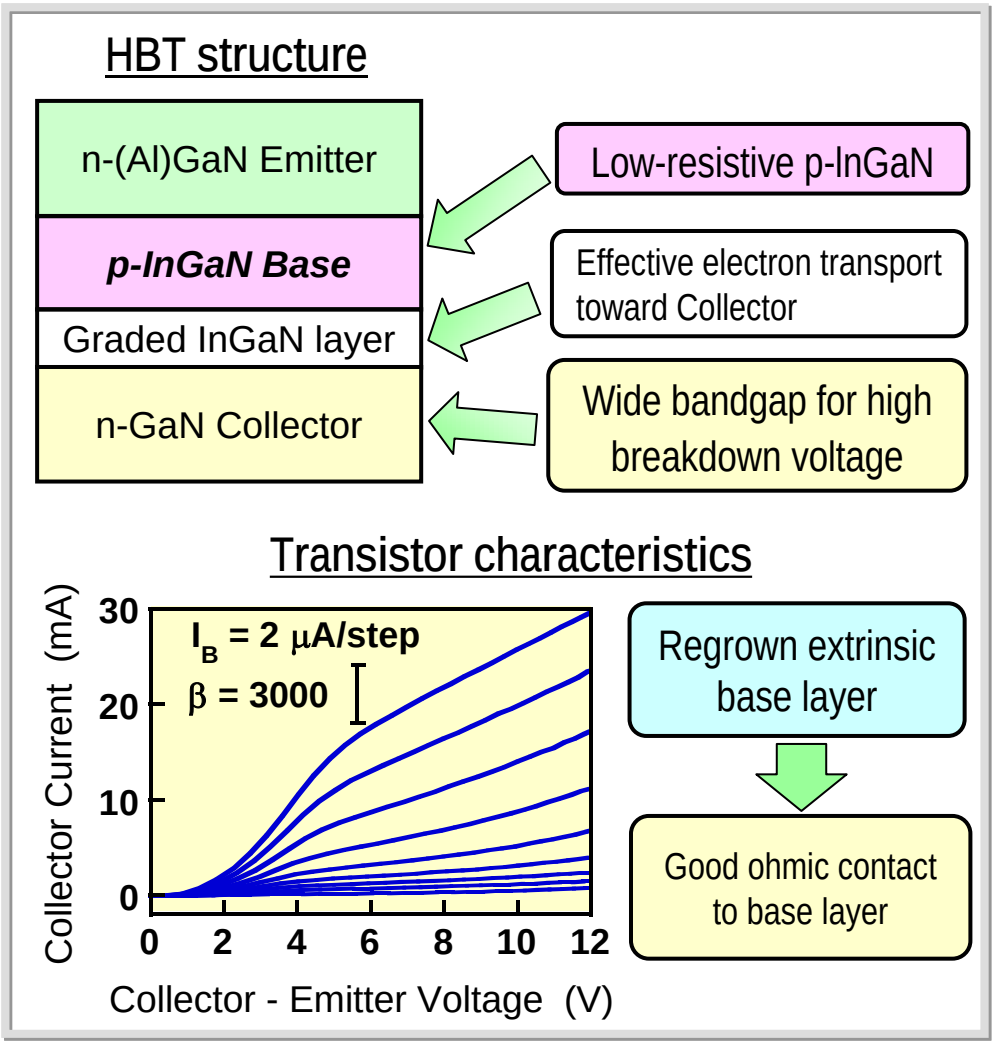
Originality

Using a low-resistive p-InGaN base and selective area regrowth technique, we have achieved high current gains of 3000 for nitride-based HBTs. They have also shown the 10-times higher breakdown electric field, which is comparable to the theoretically expected value. Furthermore, we have succeeded in high temperature operation of 300ºC in Pnp HBTs. These results indicated that nitride-based HBTs have the potentials for high power or high temperature operation.

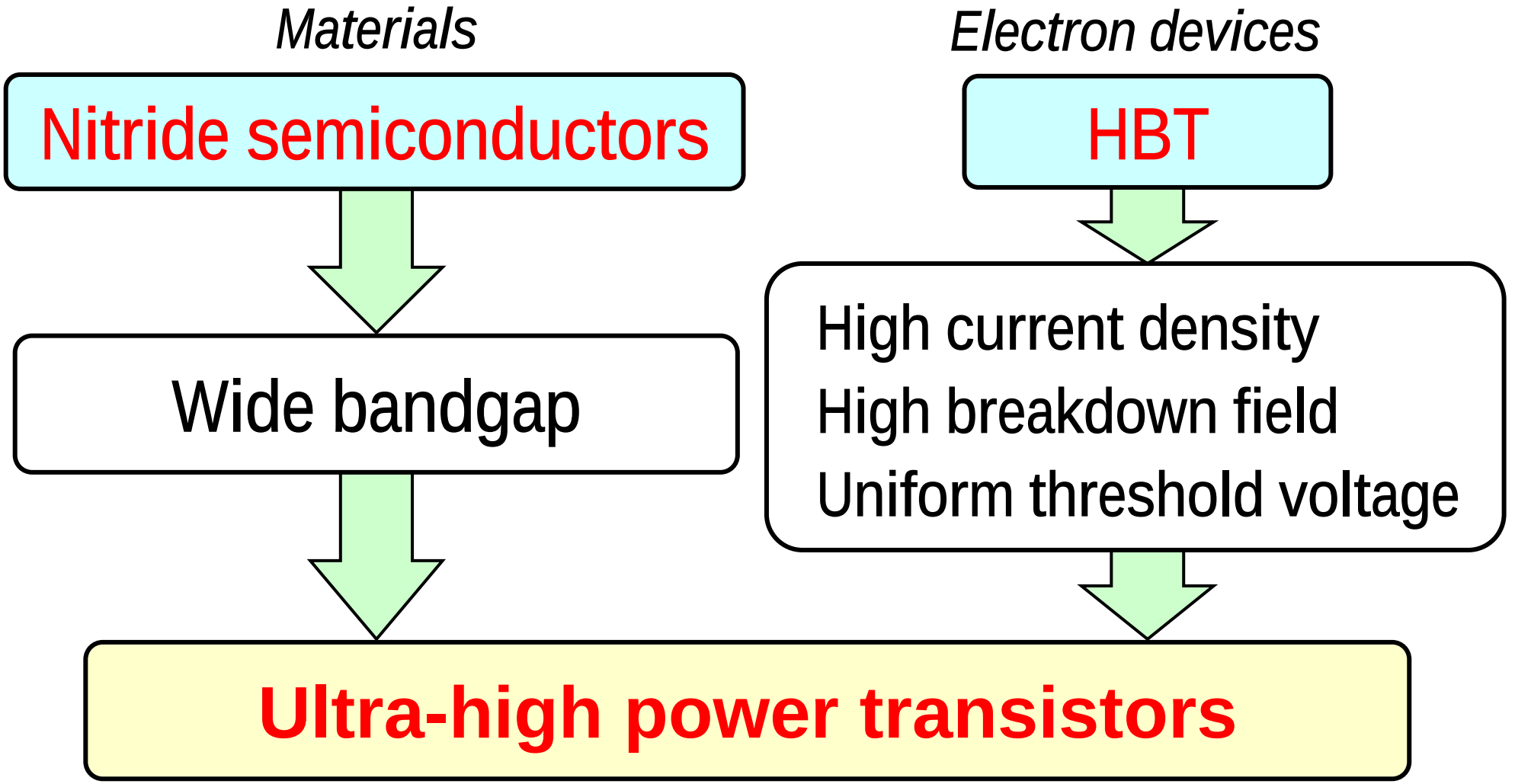
Impact

Nitride-based HBTs will be used for high power electron devices for communication between ground stations and satellites. They will reduce the system size drastically and increase the reliability, compared with vacuum tubes.

Contact person: Dr. Kazuhide Kumakura
Physical Science Laboratory, NTT Basic Research Laboratories
TEL: 046-240-3464 FAX: 046-240-4729
e-mail: kumakura@nttbrl.jp

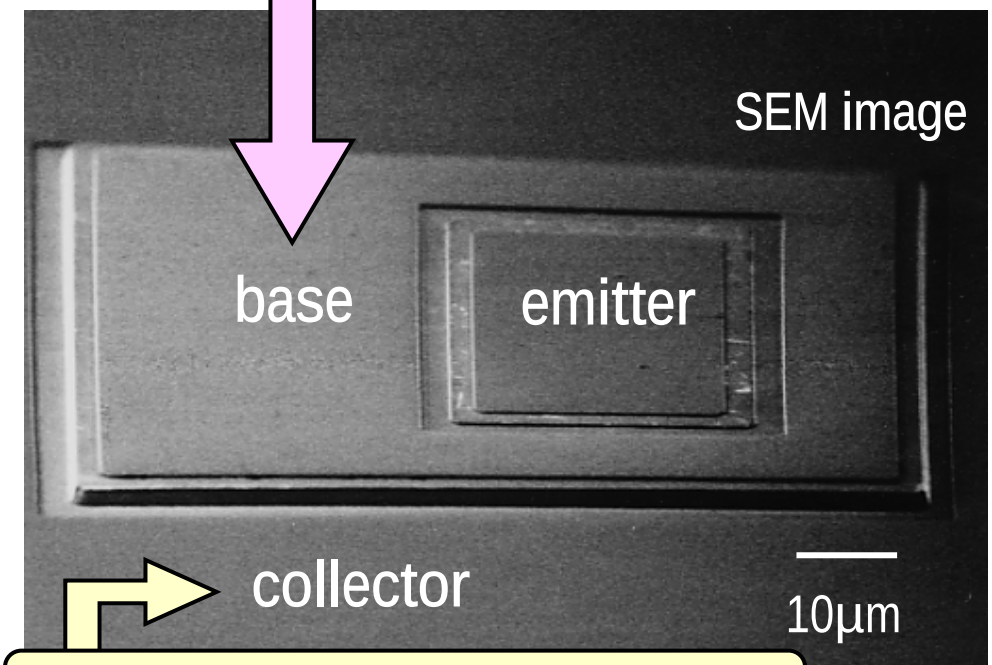


Feature of Nitride-based HBTs

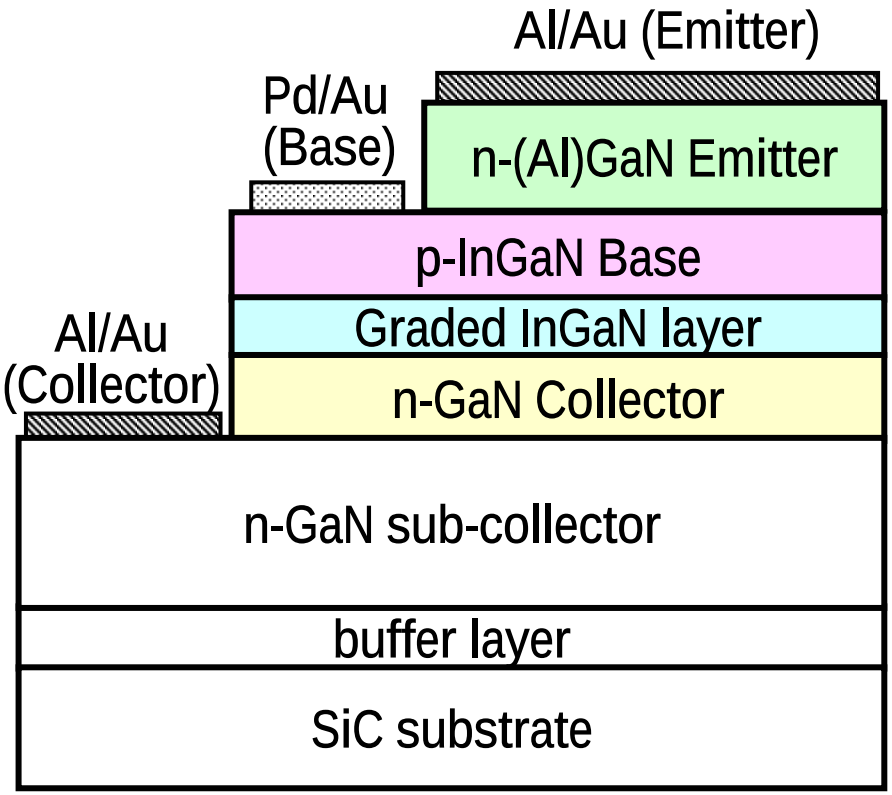


Feature of our nitride HBTs

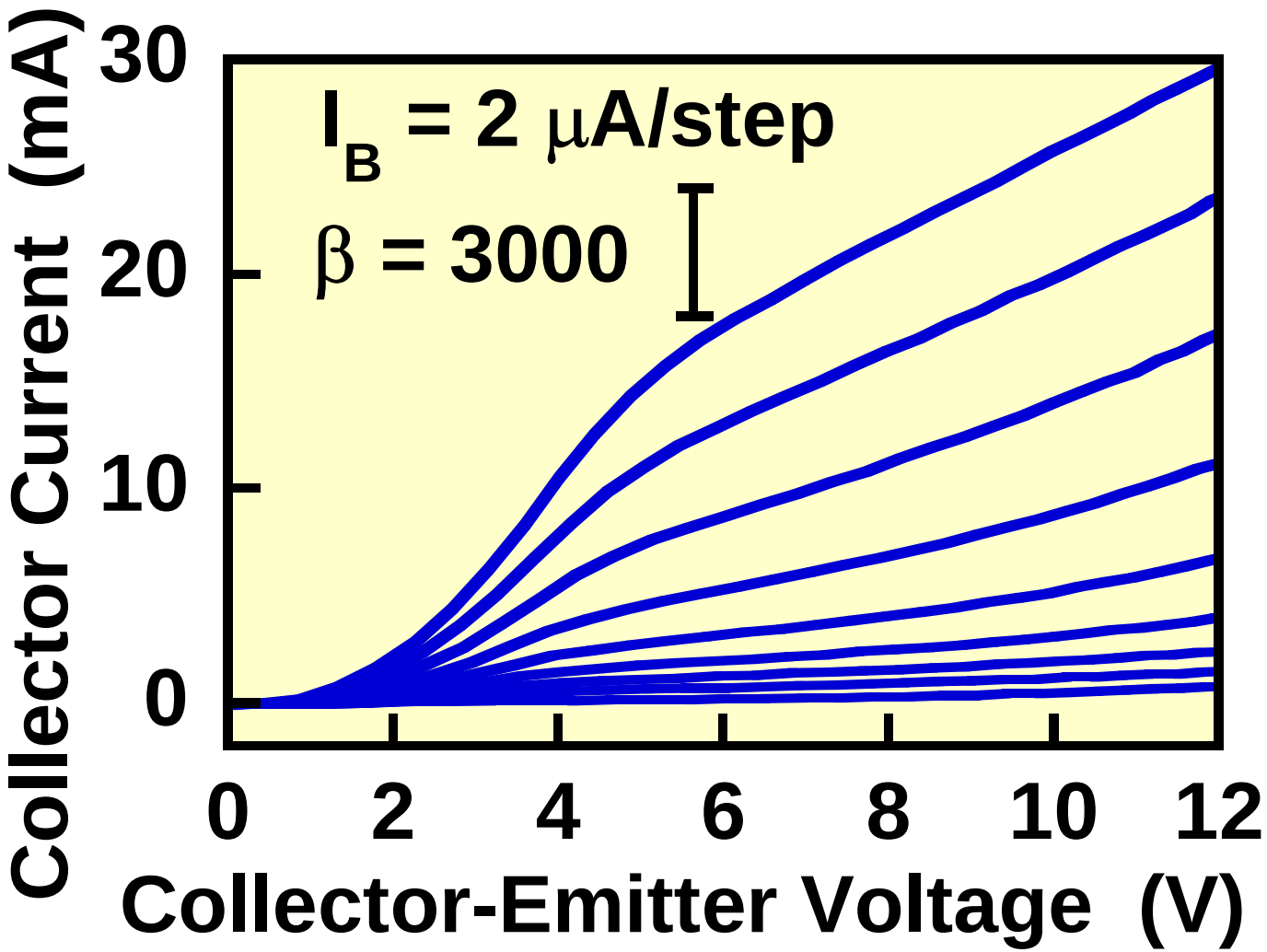
low-resistance p-InGaN



large breakdown voltage
due to wide bandgap



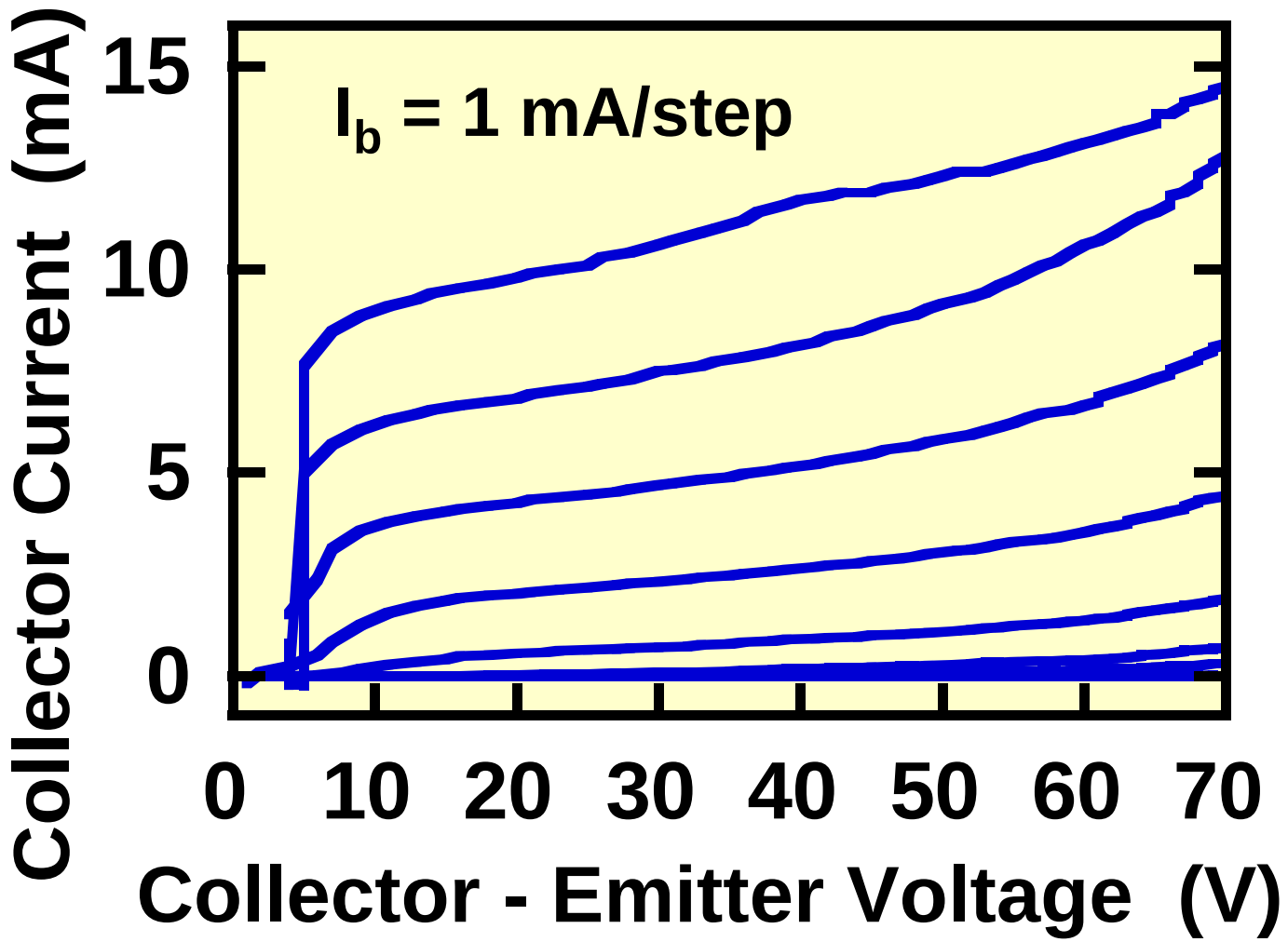
High current gain of Npn GaN/InGaN/GaN HBT



Current gain
3000 !

Maximum value among nitride HBTs

Large breakdown voltage of Npn AlGaN/InGaN/GaN HBT



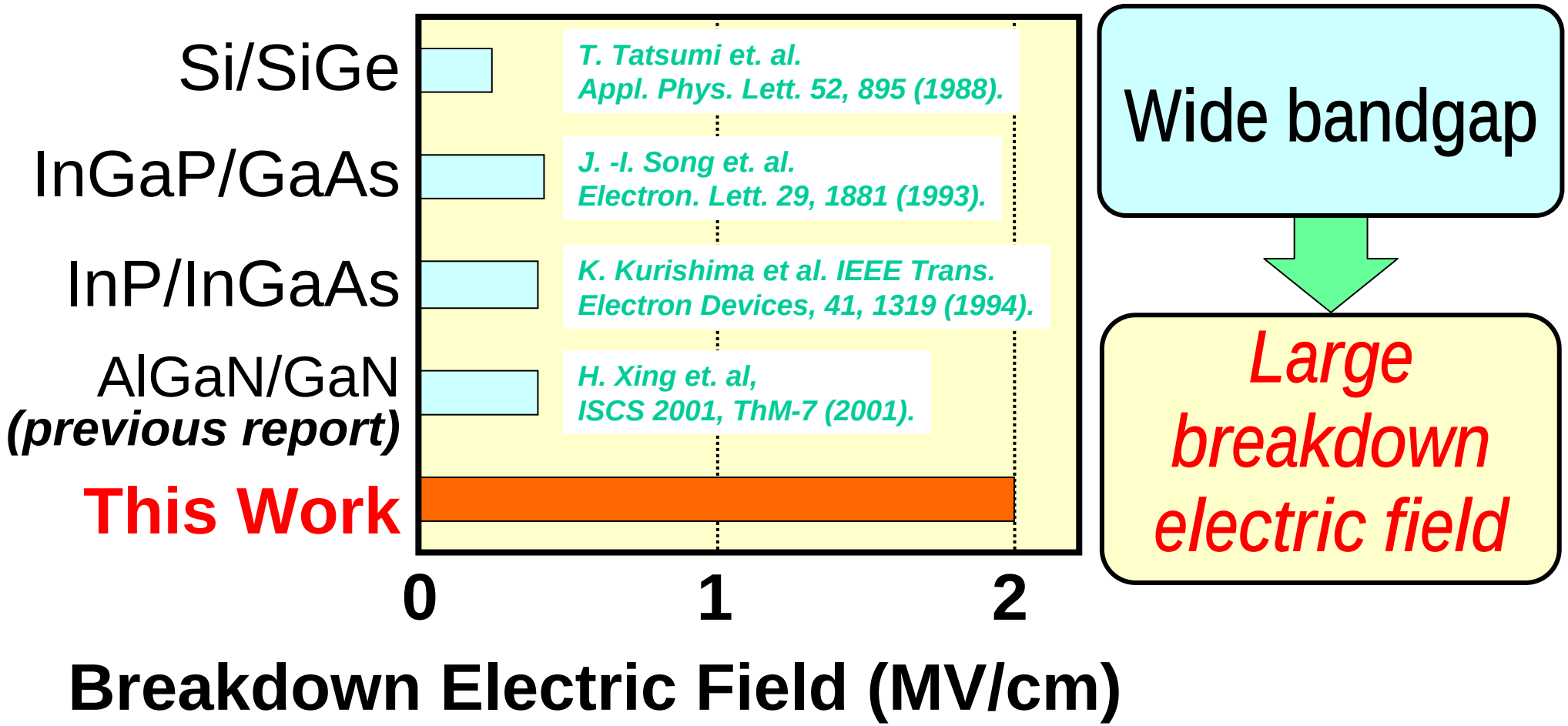
Operation
above 70 (V)

Breakdown
electric field =
2 (MV/cm)

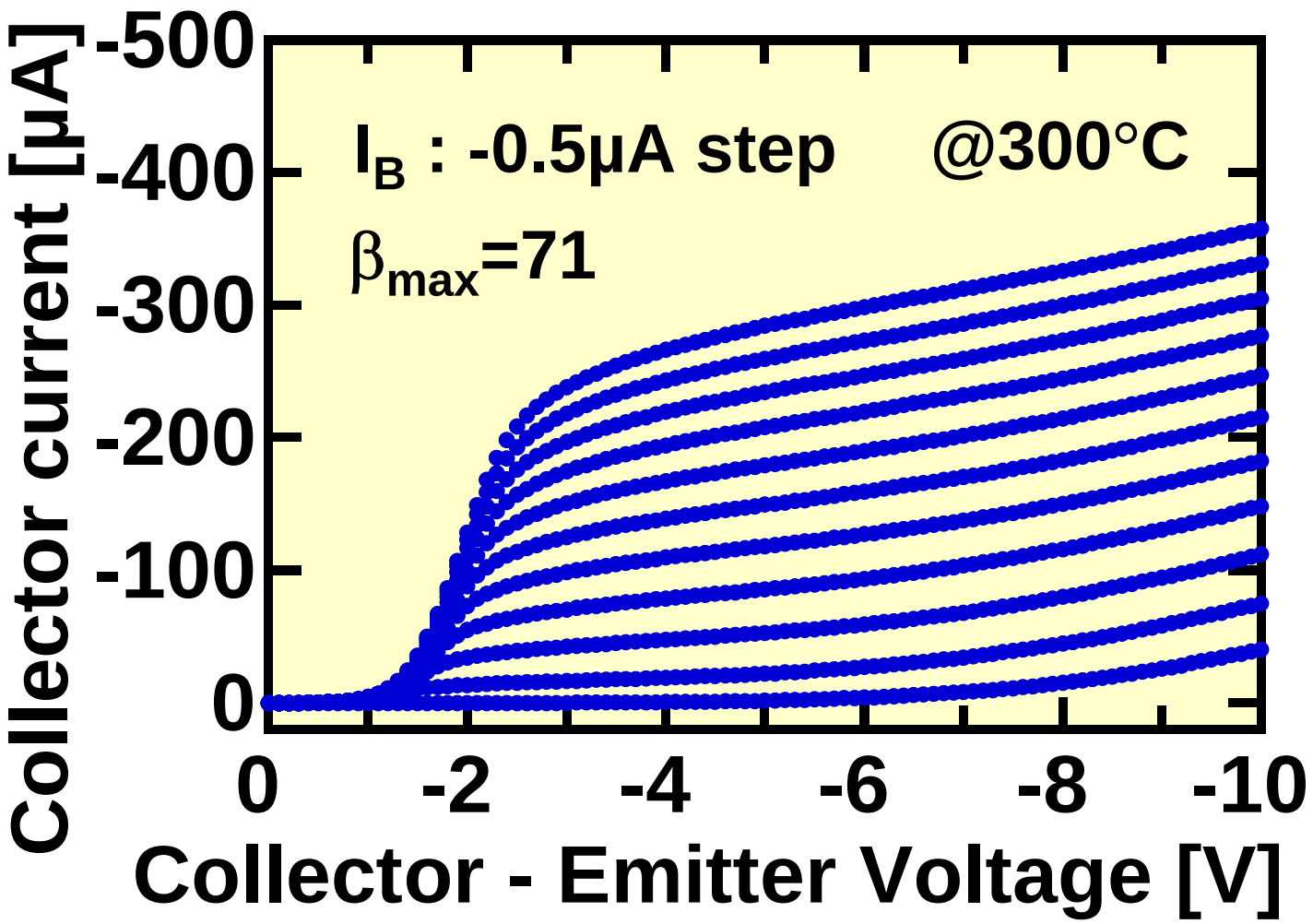
High power application

Comparison of breakdown voltage in various HBTs

HBT Materials



High temperature operation of Pnp AlGaN/GaN HBT



Ohmic device

Operation at 300 (°C)

Applicable in various circumstances