Diamond - the Next Generation Material for High Power Electronics?

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Diamond is an interesting material for many industrial applications. It may be considered a carbon ceramics, a wide bandgap semiconductor or even a refractoy metal when doped heavily. In all three areas its properties are extraordinary like its large bandgap of 5.45 eV, its high thermal conductivity, its high Youngs modulus and its high fracture strength. Thus it may be an ideal material for electronic power structures, heavy duty MEMS components and their monolithic integration. However, it lacks a natural substrate of noticeable size. Thus, electronic devices are developed on small size single-crystal chips, while MEMS structures are generally realized on polycrystalline CVD material on Si. Recently it has been possible to bridge the gap between the two materials by single crystal diamond quasi-substrates, which are grown on a foreign base (single crystal Ir on $SrTiO_3$) and then detached from this base. Therefore this may allow a fresh view onto an old dream: diamond electronics.

In this contribution a short summary of recent results will be presented in respect to the state-of-the-art of power FETs, passive RF MEMS components and the prospects of their monolithic integration. Highlights for FETs are: an f_T = 20.4 GHz and f_{max} = 32.8 GHz for L_g = 0.2 µm (fig.1) and a first RF power measurement of 0.2 W/mm at 1 GHz [1]. The expected power limit is approx. 30 W/mm [2], which is not a thermal limitation and which may allow to fabricate a 100 W power module on a chip of 4 mm x 4 mm in size.

Diamond is also an ideal microwave substrate with low loss up to very high frequencies [3]. Here a DC coupled electro-statically driven high speed diamond coplanar microwave switch will be discussed capable of operation under heavy load (estimated transmission limit in the KW-range) and high temperature (approx. 600 °C) [4]. Finally the prospects of monolithic integration in high power circuits will be discussed

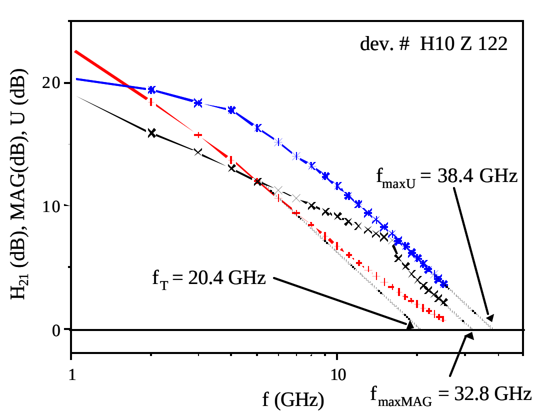

Fig.1
Gain plots of diamond surface channel FET with 0.2 µm gate length and 200 µm gate width with extraction of cut-off frequencies.

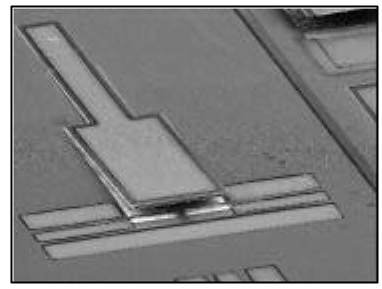

Fig.2
Micrograph of diamond coplanar switch. The switch is operated by electrostatic activation of a lateral cantilever and is DC coupled. The length of the coplanar line is 1.5 mm.

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