50 years crystal growth technology

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I sincerely thank for the many kinds of support and to former colleagues, visiting scientists and co-workers without them the results listed in the following Table could not be achieved.

1. First crystals of organic pigment dye quinacridone (Chinacridon), condition for structural research (1966).
2. Explanation of the formation of "Pyroceram" glass ceramics by phase separation causing nucleation and bulk crystallization, with G. Bayer, O.W. Flörke and W. Hoffmann (1966).
3. First large crystals of ferromagnetic semiconductor $NaCrS_2$ from Na_2S_x solvent (flux) used also for growth of many other sulfides like $NaInS_2$, $KCrS_2$, CdS, ZnS, PbS, FeS_2, CoS_2, NiS_2, MnS etc. (1974).
4. Forced convection for nucleation control and fast stable growth rates from high-temperature solutions by Accelerated Crucible Rotation Technique ACRT (1971,[1]). Hydrodynamics with E.O.Schulz-DuBois. Numerical simulation by Mihelcic et al., Kakimoto et al. and Derby et al.
5. Evaluation of maximum stable growth rates for inclusion-free crystals (with D. Elwell 1972, [1]).
6. Ultra-sensitive temperature sensor based on Pt6 versus Pt30 thermopyle with C.H.West (1973).
7. Slider-free LPE process for superlattices of p-n-GaAs (1977) and transition to facetting: atomically flat surfaces (1980) proven by Nomarski and by scanning tunneling microsopy (with G.Binnig and H. Rohrer), theory with A. Chernov (1995).
8. "Inherent" crystal growth problem of striations solved by ACRT and optimized T-control for flux growth of striation-free $KTa_{1-x}Nb_xO_3$ (KTN) solid solutions (with D. Rytz 1982), theory with R.H. Swendsen (2001), [1].
9. Flame-fusion (Verneuil) growth of $SrTiO_3$ with J. G. Bednorz (1977).
10. Growth of dislocation-free $SrTiO_3$ crystals (with J. Hutton and R.J. Nelmes 1981).
11. Distribution coefficient k=1 achieved in growth from high-temperature solutions (with R.H.Swendsen 2001).
12. First growth of colorless Anatase (TiO_2) crystals by chemical vapor transport (with M. Graetzel et al. 1996).
13. First free crystals of high-temperature superconductor $YBa_2Cu_3O_{7-x}$ and thick YBCO crystals grown from high-temperature solutions (with F. Licci, W. Sadowski 1988, 1989, [1]).
14. Leading-edge growth mechanism discovered on thin YBCO plates explaining growth of majority of thin plates in unstable growth regime (with Ph. Niedermann 1989, confirmed by H. Müller-Krumbhaar).
15. LPE of YBCO and NdBCO (with C. Klemenz 1992-1996, parallel with P. Görnert in Jena).
16. LPE of GaN (with C. Klemenz 2000).
17. Definition of 8 epitaxial growth modes (1997, in [1] and [2] 2007).

- Construction of versatile Verneuil furnace; ultra-pure glovebox system with O_2 and H_2O below detection limit; Czochralski model with four visualization methods.

-Organization of First Conference on Vapor Growth & Epitaxy 1970 (with E. Kaldis), First European Conference on Crystal Growth 1976 (with first poster sessions, with E. Kaldis), Four International Workshops on Crystal Growth Technology 1998-2008 IWCGT-1-4 (with T. Fukuda, D. Witter, P. Dutta, P. Capper, S. Uda, J. Friedrich as co-chairmen).

After brief review of the listed topics, general aspects of crystal growth for research in solid-state physics including required sufficient characterization, and education of crystal technologists for energy [3], learning about optimum crystal growth method and conditions, will be discussed.

[1] D. Elwell and H.J. Scheel, Crystal Growth from High-Temperature Solutions, Academic Press 1975, e-book with additional chapter and 2 appendices in www.hans-scheel.ch
[2] P. Capper and M. Mauk, Liquid Phase Epitaxy of Electronic, Optical and Optoelectronic Materials, Wiley 2007, 1 – 19.
[3] F.J. Bruni and H.J. Scheel, editors: WHITE PAPER: The technology of single crystals and epitaxial layers (15 April 2013), in www.hans-scheel.ch .