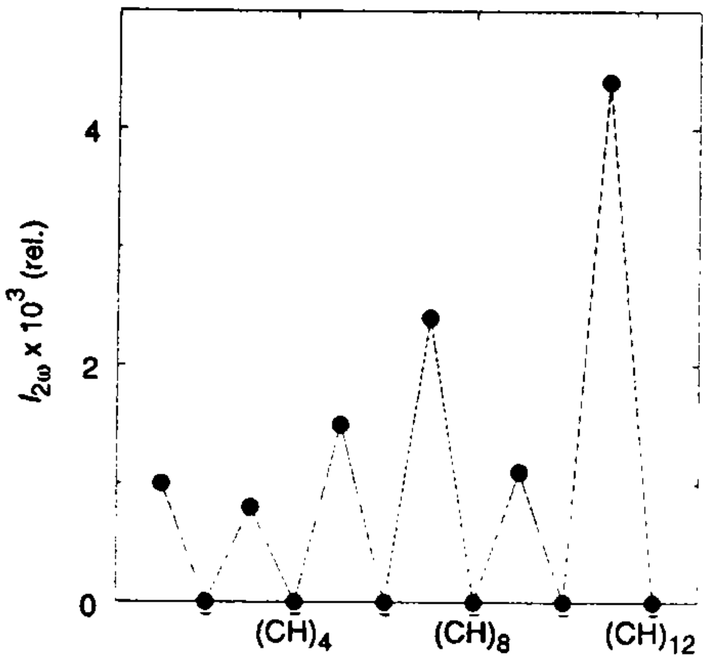

Figure 2. Powder SHG intensities relative to urea of twin 4-nitrophenol chromophores linked through the *para* positions by $-(CH_2)_n-$ units. Data are relative to urea powder. Excitation was at 1064 nm. Data from ref. 3.

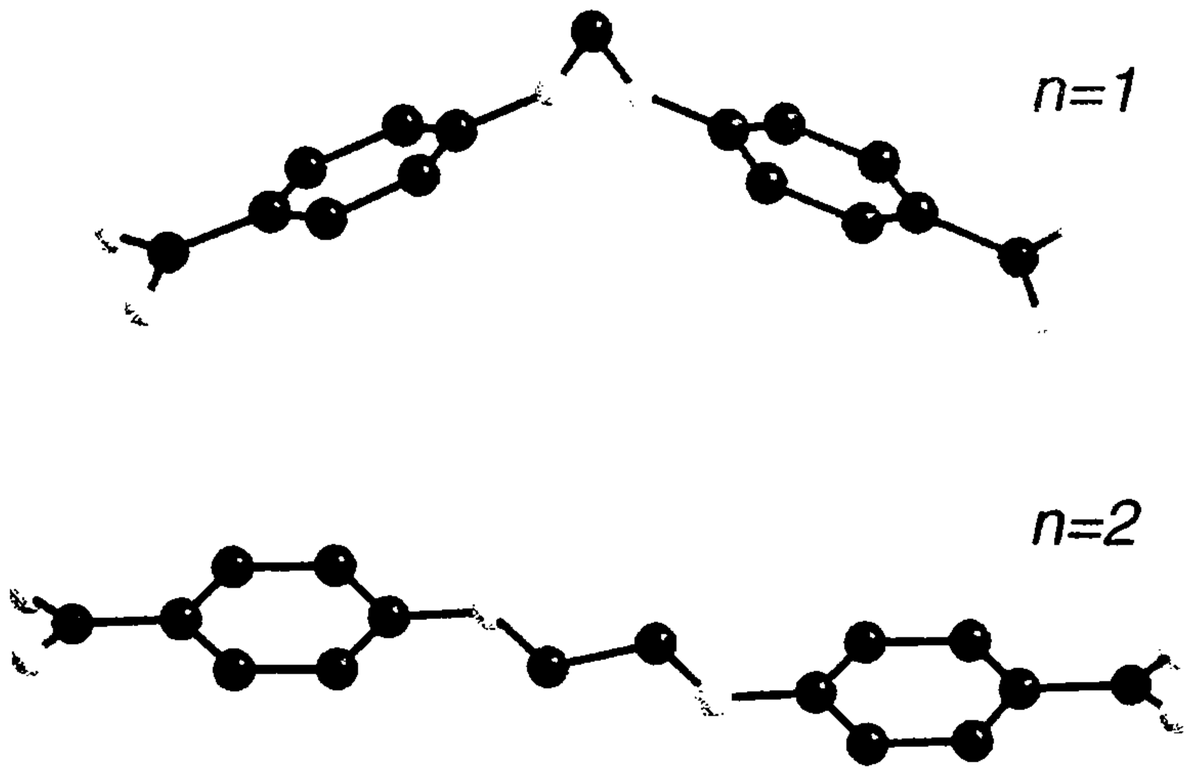

Figure 3. Molecular structures of the $n = 1$ and $n = 2$ molecules obtained from single-crystal X-ray diffraction. Dark grey, carbon; blue, nitrogen; yellow, oxygen. Unpublished data from T. N. Guru Row.

the molecules pack in the unit cell but from the *intramolecular* conformation, viz. the nature of torsions in the polymethylene chains.

The availability of single crystals of most of the members between $n = 1$ and $n = 12$ and the solution of their structures[4] has confirmed earlier speculations[3] that the even n molecules pack in the crystal in a centrosymmetric manner while odd n do not. Centrosymmetric crystals do not normally display optical nonlinearities. Figure 3 shows the structures of the $n = 1$ and $n = 2$ molecules determined by X-ray diffraction. Assuming that the molecular structures determined by X-ray diffraction are retained even when the chromophores are dispersed in polymer films, the larger SHG efficiencies found for the odd n molecules can then be attributed to the greater ease with which the chromophores separated by odd n are aligned by the poling electric field. When n is even, the molecules appear to resist such alignment.

1. Kitaigorodskii, A. I., *Molecular Crystals and Molecules*, Academic Press, New York, 1973.
2. Asha, S. K., Ray, P. C. and Ramakrishnan, S., *Polym. Bull.*, 1997, **39**, 481–487.
3. Asha, S. K., Kavita, K., Das, P. K. and Ramakrishnan, S., *Chem. Mater.*, **11**, 1999, 3352–3358.
4. Prasanna, M. D., Asha, S. K., Mallinson, P. R., Guru Row, T. N. and Ramakrishnan, S., (unpublished results).
5. Lide, D. R. (ed.), *CRC Handbook of Chemistry and Physics*, 80th edn, 1999–2000.

ACKNOWLEDGEMENTS. I thank Profs P. K. Das, T. N. Guru Row and S. Ramakrishnan for sharing their results and Mr M. D. Prasanna for providing crystal structures.

Ram Seshadri is in the Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore 560 012, India.

Random selections

On-line examination of tensile strength of polymers

'An instrument for online measurement of structural orientation in translucent polymer sheets'
P. K. Palanisamy, D. Mangaiyarkarasi and A. Ramalingam
Bull. Mater. Sci., 2000, **23**, 23

Palanisamy *et al.* have designed and fabricated an instrument, 'Laser based orientation grader' for online characterization of polymer sheets. The tensile strength, elongation and shrinkage of the polymer sheets depend on the orientation of polymer molecular chains achieved during processing. The more the longitudinal orientation, the more the tensile strength and lesser the elongation and shrinkage. Generally, one assesses the anisotropy in molecular orientation by techniques of X-ray diffraction or by tensile strength measurement techniques. The technique employed by Palanisamy *et al.* depends on the fact that a laser beam passing through an unoriented polymer strip gives rise to a circular halo diffraction whereas an oriented film gives rise to an elongated diffuse image perpendicular to the direction of orientation. The instrument provides a cost-effective, portable, non-destructive means to measure and control quality of polymer films on line during production.